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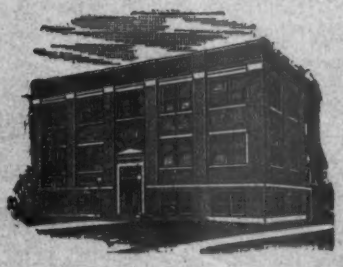

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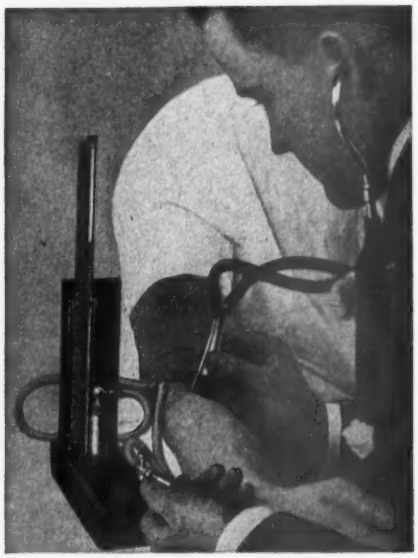

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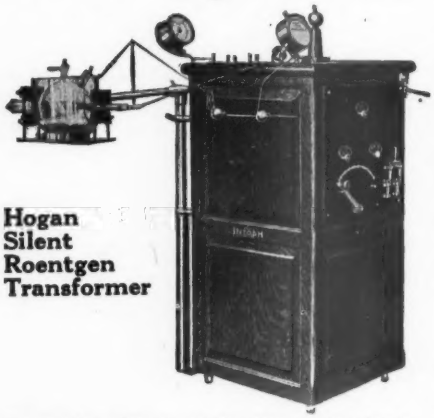

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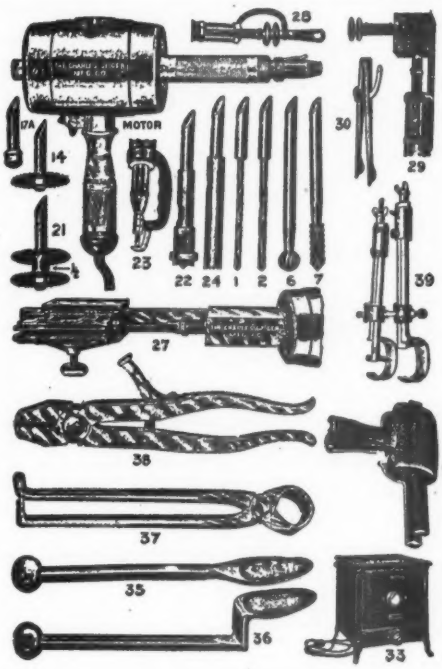

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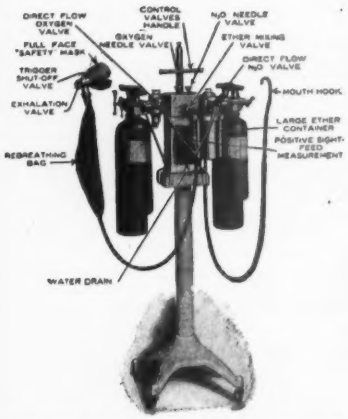

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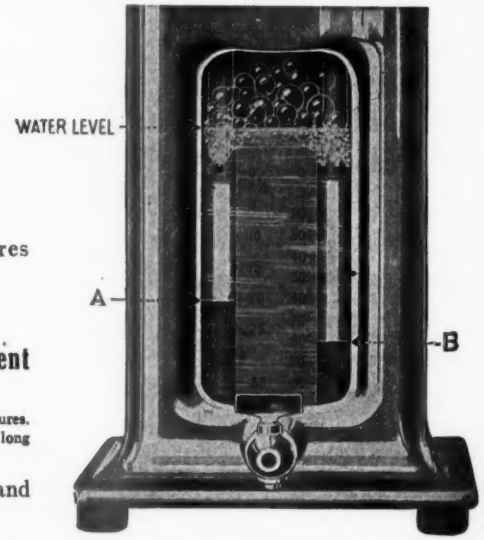

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SURGERY, GYNECOLOGY AND OBSTETRICS

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VOLUME XXVII DECEMBER, 1918 NUMBER 6

CYLINDRICAL DILATATION OF THE COMMON CAROTID ARTERY FOLLOWING PARTIAL OCCLUSION OF THE INNOMINATE AND LIGATION OF THE SUBCLAVIAN[1]

BY W. S. HALSTED, M.D., F.A.C.S., BALTIMORE

THE following unique observation confirms, on the human subject, the discovery made on dogs that a partially occluding band may cause a distal dilatation of the artery,[2] and probably sheds light on the pathogenesis of the aneurisms of the subclavian which occur in cases of cervical rib. It may, furthermore, help to explain the dilatation of the arterial trunk which I find from the perusal of about 400 reports has quite frequently been noted on the cardiac side of arteriovenous fistulæ[3] and which, in our own clinical and experimental cases has occurred invariably; and conceivably it may, eventually, lead to the discovery of a law or laws governing the preservation of the integrity of the arterial wall and thus to the better interpretation of certain pathologic phenomena of the vascular system.

Mrs. B., age 50 (Surg. No. 18357), was admitted to the Johns Hopkins Hospital October 17, 1905, suffering from a large aneurism of the right subclavian artery (Fig. 1).

November 17, 1905. *First Operation.* An aluminum band was applied to the innominate artery and tightened until the pulse in the aneurism was almost completely obliterated.

January 12, 1906. *Second Operation.* The constriction of the innominate artery having, apparently, uninfluenced the aneurism, an attempt was made to excise it. Enucleation, almost accomplished, was not completed because the sac could not be freed from the subclavian vein. Hence the subclavian artery was ligated in its first portion close to its origin from the innominate and in its third portion on the confines of the axillary artery. Both of the ligatures were tied quite close to the aneurism which had been so thoroughly freed in the course of the dissection as to make their application easy. Pulsation in the aneurism was completely interrupted for a few minutes only. Temporary occlusion of the right common carotid, which was normal in size, seemed to be without influence either before the subclavian was ligated or after the return of pulsation in the sac subsequent to the ligations. A light plaster-of-Paris dressing, completely concealing the feebly pulsating aneurism, was applied.

Ten days later (January 22, 1906) the cast was removed and the aneurism to my surprise found to be "pulseless" although little if any smaller.

December 14, 1906. Patient returned for observation. Dr. Sowers noted a slight systolic bruit in the carotid distal to the band and a "rumbling systolic bruit" in the innominate artery on the proximal side of the constriction.

April 2, 1909. There is a circumscribed, hard, non-pulsating nodule, about the size of a madeira nut, at the site of the late aneurism. Pulse in the right radial artery is palpable. No disturbance of sensation or motion is complained of. Patient states that her health is excellent and that she has not

[2] Halsted and Reid. An experimental study of circumscribed dilatation of an artery immediately distal to a partially occluding band, and its bearing on the dilatation of the subclavian artery observed in certain cases of cervical rib. Partial occlusion of the aorta with the metallic band. Observations on blood pressures and changes in the arterial walls. J. Exp. Med., 1916, xxiv, 271, 287.

[3] William Hunter, first to describe an arteriovenous aneurism, noted in his first and second cases what so many surgeons have since overlooked, that the artery concerned becomes dilatated proximal to the fistula.

William Hunter. The history of an aneurism of the aorta, with some remarks on aneurisms in general. Med. Observations Inquiries, 1757, 1, 323.

Idem. Further observations upon a particular species of aneurism. Med. Observations Inquiries, 1762, vol. ii, 390.

[1] Read by title before the American Surgical Association, Cincinnati, June 1918.

Fig. 1. Mrs. B. November, 1905. Aneurism of the right subclavian artery.

been annoyed by the loss of the clavicle and part of the manubrium. The right common carotid is dilated to about twice the normal size throughout its entire length. There is, however, no suggestion of a circumscribed, aneurism-like dilatation. The innominate artery, proximal to the band, is not enlarged.

March 31, 1911. Note by Dr. Heuer. The carotid pulstates strongly just above the level of the clavicle. This vessel is dilated, having a diameter of about 2½ cm. There is still a little mass, nonpulsating, at the site of the former aneurism. No pulse can be felt in the right radial or right brachial. The right hand is a little colder than the left, but there is no swelling of the arm, forearm, or hand.

March 16, 1917. Note by Dr. Sprunt. There is marked inequality of the radial pulses, the right being smaller.

February 15, 1918. Note by Dr. Reid. Patient has come from her home in Washington for demonstration at Dr. Halsted's Friday clinic. States that she is perfectly well and has no abnormal sensations. Pressure over and just above the band compels a cough. The right hand seems as strong as the left and the sensation of a cold right hand of which she was formally conscious has altogether vanished. The last trace of the old aneurismal sac is gone. The band is definitely though indistinctly palpable. There is a marked dilatation of the right common carotid from the band to the bifurcation (Figs. 2 and 3). Below the band one can trace the innominate artery for a short distance; it is certainly not dilated.

The dilatation of the carotic is somewhat fusiform at its central end. The greatest width of the artery (2.8 centimeters) is about 1 centimeter

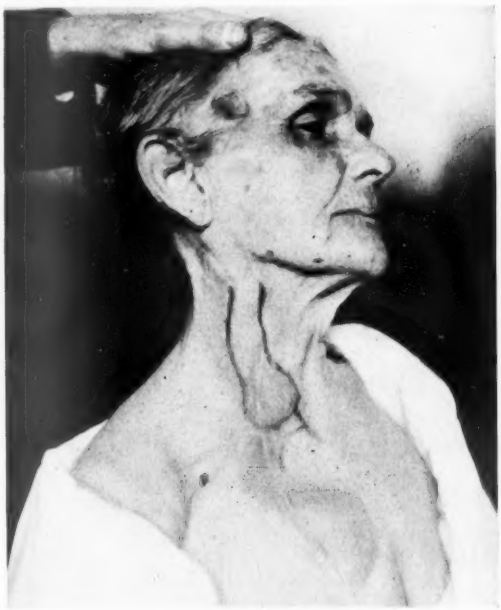

Fig. 2. Mrs. B. February, 1918. Twelve and one-half years after the application of a partially occluding band to the innominate artery and ligation of the right subclavian artery in its first and third portions. Distal to the band the innominate and carotid arteries are dilated. Outlined by Dr. Sowers.

above the upper edge of the band. From this point the diameter diminishes rather rapidly, losing 1 centimeter in an equal stretch of the vessel, which then maintains an almost cylindrical but slightly tapering form to the bifurcation (Fig. 3). The innominate, which, at the operation was considerably constricted by the metal tube, is now smaller below than above it—smaller probably than normal. A distinct bruit, audible along the whole course of the right carotid, is loudest just above the band. It is not heard below it, over the innominate. Pressure, here, on the innominate obliterates the pulse in the carotid. The blood is surely coursing through the aluminum tube. The heart is not demonstrably enlarged, nor is the aorta. The right radial pulse is feeble, but easily countable. The systolic pressure is 80+; the diastolic pressure cannot be accurately determined. In the left arm the blood pressure is 180/90.

Thus on the human subject we have, now, a striking confirmation of the observations which Dr. Reid and I have made upon the aorta of dogs.

Four or five times in the past twelve and a half years this most obliging of patients has

Fig. 3. Mrs. B. February 15, 1918. Diagram made from Dr. Reid's measurements.

journeyed to Baltimore in response to my letters, and nine years ago I made a note of the remarkable manifestation — a cylindrical dilatation of the common carotid throughout its entire length. But not until this year did the explanation of the phenomenon occur to me, although for many years I have pondered the subject of the dilatations distal to the point of constriction in cases of cervical rib and four years ago observed for the first time a dilatation of the aorta, distal to a partially occluding band, in the dog (Plate 1). How true it is, for some at least, that facts may almost smite us in the face and still pass unobserved.

In the analysis of 525 clinical cases of cervical rib we found 106 in which the subclavian artery had been compressed, and that in 27 of these aneurism or dilatation of this vessel distal to the site of constriction had been noted. Interesting illustrations appear in the papers of Keen [1] and Law [2] (Figs. 4 and 5).

DILATATION OF THE HEART IN CASES OF ARTERIOVENOUS FISTULA

A particularly interesting result of our clinical and experimental studies of arteriovenous fistula is the discovery that enlargement of the heart probably occurs, after a time, as a rule in the major cases. My attention was forcibly called to this complication some ten years ago by a case of fistula of the femoral vessels which I saw in consultation with James F. Mitchell of Washington and

[1] Keen, W. W. The symptomatology, diagnosis, and surgical treatment of cervical ribs. Am. J. M. Sc., 1907, cxxxiii, 173.

[2] Law, A. A. The surgical aspect of cervical ribs. J. Lancet, 1914, xxxiv, 330.

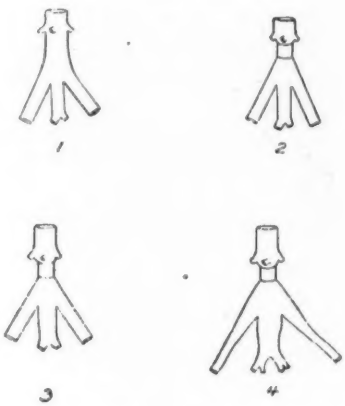

Plate 1. Dog 7, Series 1. The figures are actual size. Fig. 1. Aorta before the band was applied. Fig. 2. Immediately after application of the band. Fig. 3. Two months thereafter. Fig. 4. Six months and 19 days thereafter. (Reproduced from the *Journal of Experimental Medicine* by courtesy of the editor.)

upon which together we operated in the Providence Hospital. The phenomenal enlargement of the heart must, I thought, have been due to the fistula, and have been secondary to the enormous dilatation of the aorta and vena cava. Since then we have more carefully noted the condition of the heart in our cases of arteriovenous aneurism and have, I believe, quite invariably found

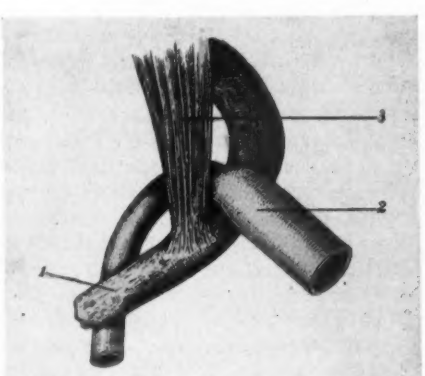

Fig. 4. 1, Cervical rib; 2, subclavian artery dilated distal to the site of constriction; 3, scalenus anticus muscle. (Reproduced by courtesy of Dr. W. W. Keen and the editor of the *American Journal of Medical Sciences.*)

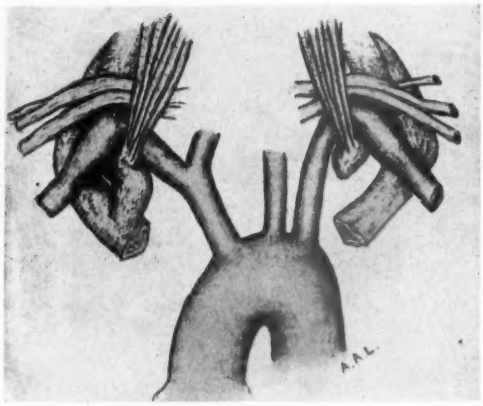

Fig. 5. Dilatation of the right and left subclavian arteries above the cervical ribs and distal to the site of constriction. (Reproduced by the courtesy of Dr. Arthur A. Law and the editor of the *Journal-Lancet.*)

the heart enlarged—strikingly so in several instances.

If the assumption is correct that the heart dilates in consequence of the fistula it is important that the fact should be brought to the attention not only of surgeons but also of pathologists and internists who apparently have overlooked it. Dr. Mont Reid has in preparation a report upon his experimental and clinical work in arteriovenous fistula in which he will offer convincing experimental proof of our view that the fistula may in its consequences profoundly affect the heart as well as the veins and arteries; and Dr. Cure L. Callander is making a careful study of all the reported cases of arteriovenous fistula in order to weigh the clinical evidence bearing on this subject which these records may furnish.

When a causative relationship between arteriovenous fistula and dilatation-hypertrophy of the heart shall have become convincingly established we may find that some unexplained dilatations of the heart are referable to hitherto undetected changes in the walls and lumen of the blood-vessels. That a very considerable dilatation of blood-vessels may be overlooked at autopsy, our experiment in the partial occlusion of arteries has convinced us. It is impossible to estimate the amount of dilatation of either an artery or vein in their collapsed state. Arteries as well

Fig. 6. Dilatation of the external and common iliac arteries and veins proximal to a fistula of the superficial femoral vessels. (Reproduced by the courtesy of Dr. A. B. Eisenbrey and the editor of the *Journal of the American Medical Association.*)

as veins which, when empty, give no indication of increase in caliber may, on injection, prove to have been markedly dilated. All surgeons know how true this is of veins. A vein to which, when full of blood, von Langenbeck in deference would, as he said, remove his hat might, when empty, be hardly recognizable in the course of an operation.

There may be more or less circumscribed aneurismal expansions in the continuity of the otherwise cylindrically dilated, proximal arterial trunks. I have observed this in two or three of my patients. One such expansion is shown proximal to the fistula in the post-mortem specimen of a famous case reported by Osler[1] (Fig. 7) and another in Eisenbrey's[2]

[1] Osler, Sir Wm. Case of arteriovenous aneurism of the axillary artery and vein of fourteen years' duration. Ann. Surg., Phila., 1803, xxvii, 37.
Ibid. An arteriovenous aneurism of the axillary vessels of thirty years' duration. Lancet, Lond., 1913, ii, 1248.
Makins, G. H. Surgical experiences in South Africa, 2d. ed., 1913, p. 148.

[2] Eisenbrey, A B. Arteriovenous aneurism of the superficial femoral vessels. J. Am. M. Ass., 1913, lxi, 2155.

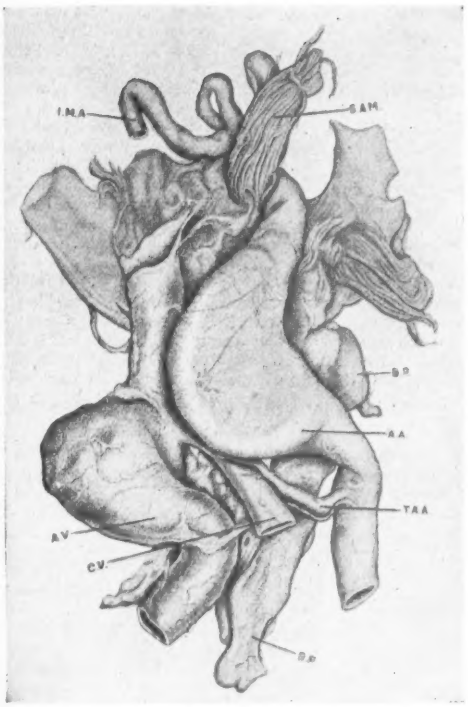

Fig. 7. Dilatation of the axillary artery and vein proximal to a fistula of 30 years' duration. *SAM*, scalenus anticus muscle; *IMA*, internal mammary artery; *BP*, brachial plexus; *AA*, axillary artery; *AV*, axillary vein; *CV*, cephalic vein; *TAA*, thoracico-acromial artery. (Reproduced by the courtesy of Sir William Osler and the editor of the *London Lancet*.)

particularly instructive illustration (Fig. 6). I am quite sure that in Osler's case there was a much greater dilatation of the artery above the aneurism and between the aneurism and the fistula than the drawing indicates, for, as I have said, one cannot judge of the size of the lumen from the appearance of the empty vessel. It would interest Sir William to compare the very similar drawings illustrative of the two cases, his own and Eisenbrey's, as the latter's proves that the fistula may be a considerable distance below the point at which the artery has become conspicuously dilated and thus offers strong presumptive evidence that the reason why the specimen of the former lacks the evidence of the fistula is because it was too greatly

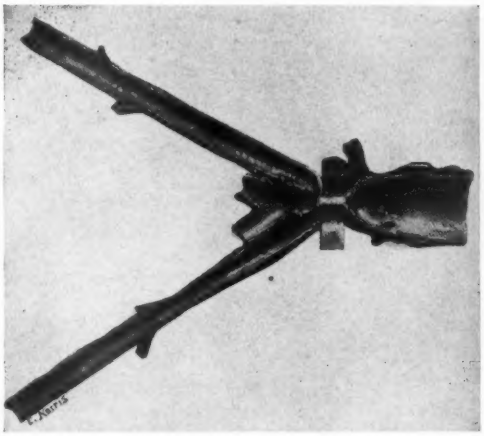

Fig. 8. Complete occulsion of the aorta of a dog by a metal band. Note the absence of dilatation below the band 7 months after its application. (Reproduced by the courtesy of the editor of the *Journal of Experimental Medicine*.)

curtailed by the pathologist. The pathologist, by the way, should not be too harshly censured for missing the key to the situation, for if, perchance, he had been aware that the artery should be dilated central to the fistula he could hardly by any possibility have known that it might retain approximately its normal caliber for a distance so far from the arteriovenous communication.

Thanks to the assistance of highly competent secretaries I have abstracts of 380 cases of arteriovenous fistula. These have been studied with especial reference to occasional observations on the dilatation of the artery. In 52 instances proximal dilatation of the arterial trunk has been noted. In 11, dilatation was mentioned, but whether proximal or distal or both is not specified. I am quite sure that in almost every instance in which the fistula had existed two or more months proximal dilatation of the artery would have been ascertainable if looked for. The size of the involved artery both above and below the fistula should always be compared with that of its fellow. The dilatation in the older cases extends as a rule probably to the heart which also in my opinion is quite likely, as I have said, to be dilated. The size of the narrowed artery below the fistula may

Fig. 9. The aorta of a dog 8 months after ligation. Aorta dilated distal to the site of the ligation. (*Luigi Porta.*)

be difficult to determine without dissection. In view of our observations it would be well also to bear in mind the possibility of a dilatation of any great artery distal to the site of ligation, and the probability of such dilatation if, perchance, the lumen were, in some measure, re-established. As the dilatation distal to a totally occluding ligature has been observed by us only in dogs and only in the aorta and its triad of branches, further experimentation is necessary for the determination of the part played by other possible factors, for example, by the anastomotic circulation and by the proximity of the nearest branches—by the length of the dead arterial pocket, in other words.

In a previous paper [1] I made the statement that dilatation had not been observed below a totally occluding band (Fig. 8). Since then, however, a slight degree of dilatation, distal to the completely obturated vessel, has taken place in three instances. A dilatation of this ventricle-like portion of the aorta between the band and the trifurcation might be expected even in case of complete occlusion, for the anastomosis is very free in this situation and the dead pocket is usually, and perhaps always, too short to become obliterated. Lumbar branches may be given off just below, as they are just above, the band.

[1] Halsted and Reid (Loc. cit.).

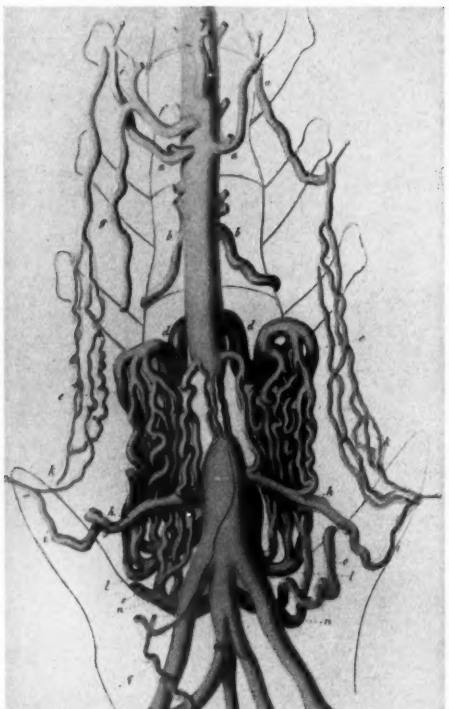

Fig. 10. The aorta of a dog 15 months after ligation. Note the distal dilatation and the anastomotic circulation. (*Luigi Porta.*)

In two instances I have made the following observation in testing, during the life of the animal, for the patency of the aorta under the band. Pressure with the finger immediately above the band shut off the pulse in what we term the ventricle; whereas, pressure with the back of the scalpel-blade, made as close to the band as possible, did not. In these cases there was a patent lumbar artery so close to the proximal edge of the band that pressure by the finger obliterated it, whereas,

the knife blade which could be brought to bear on the aortic wall between this little artery and the upper edge of the band did not interrupt the flow in this important anastomotic branch. The contribution of this little artery to the anastomotic blood-stream was sufficient to convert an impalpable into a palpable pulse. A palpable pulse in the ventricle below the band is so invariable, whether the aorta has been completely occluded or not, that the patency of the artery under the band cannot be definitely determined during the life of the animal unless temporary occlusion of it between the band and the nearest lumbar artery obliterates or decidedly influences the pulse in the ventricle. If pressure above the band does not affect the pulse just below it we may conclude that obturation is complete.

Fortunately it occurred to me a few days ago to restudy, with reference to the possibility of finding depicted a dilatation of an artery below a ligature, the sketches of surgeons who in bygone years had experimentally ligated the blood-vessels of animals. I was delightfully surprised to find, in the beautifully illustrated volume of Luigi Porta [1] published in 1845 two drawings which portray a pronounced dilatation of the aorta and its ventricle immediately below the site of ligation (Figs. 9 and 10). The ligatures in the two dogs had been applied 8 and 15 months before the death of the animals. There is a great bundle of dilated vessels—the vasa vasis—bridging the gap between the retracted ends of the dilated aorta.

Thus three-quarters of a century ago this great, perhaps the greatest, surgeon of Italy furnished irrefutable proof of a remarkable phenomenon which must eventually have interest for the physiologist, the pathologist, and the surgeon. Luigi Porta describes the drawing but makes no further comment upon the dilatation.

Before the introduction of antiseptic surgery by Lister, thrombosis quite invariably followed ligation of an artery, and it was to the organization of the thrombus that the surgeon looked for the prevention of secondary hæmorrhage and for the preservation of the life of the patient. If thrombi formed in these two cases of Porta they must have been eventually absorbed, for the distribution of the dilated vasa vasis proves that the aortic stumps were patulous, and we have further proof of this in the dilatation of the aortic ventricle just below the site of the ligation.

In the course of my experiments in partial occlusion of the arteries, I have often studied the illustrations, carefully I thought, in Luigi Porta's work, but not until I scanned them with the particular object in view did I discover the dilatations so strikingly manifest. I doubt if anyone has ever commented upon or been interested in these two observations of Porta.

The following summary is quoted from a paper presented before the National Academy of Sciences in April of this year.

SUMMARY.

1. A partially occluded artery (abdominal aorta, innominate, carotid, subclavian) may dilate distal to the site of constriction.

2. The dilatation is circumscribed and has been greatest when the lumen of the artery (the aorta) was reduced to about one-third or perhaps one-fourth of its original size.

3. When the obturation has been slight in amount dilatation has not been observed; of 7 cases of complete obstruction there was a very moderate degree of dilatation in 3, and none in 4.

4. Complete or partial occlusion of the thoracic aorta may be followed by dilatation central to the point of constriction.

5. Dilatation or aneurism of the subclavian artery had been observed twenty-seven or more times in cases of cervical rib.

6. The dilatation of the subclavian is circumscribed, is distal to the point of constriction, and strikingly resembles the dilatation which we have produced experimentally.

7. The dilatation of the artery proximal to an arteriovenous fistula and distal to a partially occluding band may prove to be referable to the same cause.

8. When the lumen of the aorta is considerably constricted the systolic pressure may be permanently so lowered and the diastolic

[1] Luigi Porta. Delle alterazioni patologiche delle arterie par la legatura e la torsione. Milano, 1845, pp. 350, 351, plate V, Figs. 3 and 5.

pressure so increased that the pulse pressure may be diminished by one half.

9. The experimentally produced dilatations and the aneurisms of the subclavian artery in cases of cervical rib are probably not due to vasomotor paralysis, trauma, or sudden variations in blood pressure.

10. The abnormal, whirlpool-like play of the blood in the relatively dead pocket just below the site of the constriction, and the lowered pulse pressure may be the chief factors concerned in producing the dilatation.

11. Bands, rolled ever so tightly, do not rupture the intima.

12. Intimal surfaces brought, however gently, in contact by bands or ligatures do not, in our experience, unite by first intention, for the force necessary to occlude the artery is sufficient to cause necrosis of the arterial wall.

13. The death of the arterial wall having been brought about by the pressure of the band, a gradual substitution of the necrotic tissue takes place, the new vessels penetrating it from both ends. It is, I believe, in this manner that an artery becomes occluded, and it is thus that a fibrous cord forms within the constricting band.

A STUDY OF EMPYEMA CASES AT CAMP DONIPHAN

By Major C. B. INGRAHAM, M.C., Captain JOHN A. RODDY, M.C., and Captain JOSEPH D. ARONSON, M.C.

THE epidemic of pneumonia which existed in practically all military camps during the early part of the year 1918 was soon recognized as a serious situation. Many of these cases were complicated by empyema, the treatment of which has not been any too satisfactory. At once measures were adopted to curb this epidemic. The surgical complication gave evidence of the greatest possibilities. Consequently empyema teams were formed consisting of a surgeon, an internest, and a laboratory worker, appointed by the commanding officer at the suggestion of the Surgical Division, from the personnel of each Base Hospital, the object being to stimulate more intensive study of empyema to insure better treatment and, if possible, to add something to our present knowledge of the condition. A concise review of the efforts from Camp Doniphan follows. —Editor.

In this hospital, cases classified as empyema are those in which pus or exudate, with bacteria, exists in the pleural cavity.

From November 2, 1917, to May 4, 1918, there were 148 cases; in November, 16; December, 42; January, 42; February, 21; March, 10; April, 11; May, 6. Practically all men affected were in the third decade of life, and the average period of military service before admission to the hospital was three-twelfths years.

Some of the regiments of the 35th Division were composed of men from urban and others from rural communities. Fifty-eight per cent of the cases of empyema came from regiments made up almost entirely of men from rural districts, 24 per cent from regiments composed of both urban and rural men, and only 8 per cent from regiments of urban men.

CLASSIFICATION

There were 11 primary cases in which signs and symptoms indicated the pleura as the first and principal site of disease without any evidence of recent or remote preceding infection of the respiratory tract, nasal, frontal sinus, or systemic disease. The other 137 gave a history, and many showed signs of recent acute rhinitis, laryngitis, tonsillitis, or bronchitis, and are therefore referred to as secondary.

Onset. The onset was sudden in 47 per cent, gradual in 34 per cent, and insidious in 19 per cent of the cases diagnosed before death. There were 22 cases not recognized until

35TH DIVISION

Organization	Personnel Rural or Urban	Number of Cases	Per Cent
137th Infantry	Rural	23	15.5
138th Infantry	St. Louis	7	4.7
139th Infantry	Rural	27	18.3
140th Infantry	Mixed	23	15.5
128th Field Artillery	St. Louis	2	1.4
129th Field Artillery	Kansas City	2	1.4
130th Field Artillery	Rural	6	4.0
128th Machine Gun Battalion	Rural	10	6.7
129th Machine Gun Battalion	Rural	4	2.7
130th Machine Gun Battalion	Rural	0	0.0
110th Trench Mortar Battalion	Rural	2	1.4
110th Ammunition Train	Draft	5	3.3
110th Field Signal Battalion	Rural	1	.7
110th Engineers	Mixed	9	6.0
110th Supply Train	St. Louis	2	1.4
110th Sanitary Train	Rural	6	4.0
110th Military Police	Rural	3	2.0
Detachment Base Hospital	Rural	4	2.7
Auxilliary Remount No. 327	Mixed	4	2.7
Field Bakery No. 317	Regulars	1	.7
Field Bakery No. 347	Regulars	1	.7
Casual Camp	?	1	.7
1st Balloon Squad	?	1	.7
39th Balloon Squad	?	1	.7
11th Field Artillery	?	2	1.4
Total		148	100.0

	Number	Per cent
Rural	86	58.1
Urban	13	8.8
Mixed	36	24.3
Unknown	13	8.8
Total	148	100.0

autopsy. Sudden onset was most frequent in primary empyema (70 per cent), least frequent in empyema occurring after long illness with measles and pneumonia (14 per cent). Insidious onset was most frequently observed following measles and pneumonia.

In general, the symptoms conformed with accepted descriptions: Pain in the chest, referred to the region of breast or angle of the scapula on the affected side was the most constant, most distressing and most suggestive symptom; lancinating pain, sometimes gradual, more often sudden in onset, accentuated by any movement, especially by inspiration, lasting in almost all cases for several days but in some throughout the disease.

This symptom was not present in all cases. In many it was no more severe than frequently met in pneumonia, nor more prolonged than in pleurisy without pus, but in about 50 per cent of the cases it was the dominant symptom and suggested the correct diagnosis.

In a few cases constant, dull pain, diffused throughout the chest, with no point of maximum intensity was found. In one case, several days before the onset, pain, suggestive of acute periostitis of the tibia, was reported. In four cases, prior to development of pain or physical signs in chest, there was severe pain in the abdomen with slight tenderness in the subdiaphragmatic area; in two other cases, pain and tenderness localized at McBurney's point, was the first evidence of disease.

Dyspnœa was not a symptom of diagnostic value. In the majority of cases terminating favorably it was slight and of short duration (several days). In some cases it was absent throughout the disease, and whenever present this symptom had but slight diagnostic value.

PHYSICAL SIGNS

The physical signs indicative of accumulation of fluid in the pleural cavity were all elicited; but only occasionally before the end of the first week of the disease.

Inspection. Changes in contour and motion suggestive of fluid in the chest were observed in 5 per cent of the cases.

Palpation. Decrease in or absence of normal fremitus was detected in 76 per cent; increased fremitus found in 9 per cent.

Percussion. Extreme dullness or flatness suggestive of fluid in the chest was elicited in 60 per cent of the cases. Changes in percussion sound caused by change of patient's position were noted in 5 per cent. Hyperresonance was elicited above the area of dullness or flatness in less than half the cases.

Auscultation. Pleural friction was heard in 15 per cent of the cases; vocal and breath sounds were diminished in 50 per cent and absent in 10 per cent over the site of fluid, increased in 8 per cent, and intensity not noticeably altered in the remainder.

COURSE

Empyema occurred secondary to demonstrable infection elsewhere in the body in more than 90 per cent of the cases. Strepto-

cocci alone were found in the pus from 132 of the cases, pneumococci alone were found in 9, pneumococcus and streptococcus occurred together in 7.

The course in favorable cases has been that of a localized severe streptococcus infection and in the fatal cases that of a streptococcus septicæmia, usually with multiple foci of infection in adjacent or remote organs.

There was leucocytosis, which showed only slight fluctuations, throughout the disease in practically all cases; the lowest count was 12,000, the highest 40,000: average about 20,000. The polymorphonuclears always predominated, in some cases constituting 95 per cent of the cells. No distinctive difference, in either the total or differential white cell count between mild and severe or between fatal cases and recoveries, was found.

In cases of sudden and gradual onset subjective symptoms (except dyspnœa) usually increased in intensity throughout the first 3 to 6 days, gradually subsiding thereafter in favorable cases; in the more severe cases after the first week asthenia progressed rapidly to a degree proportionately greater than the signs and symptoms would lead one to expect, a more grave loss of vitality and resistance than observed in any other group of patients in the hospital. Physical signs of fluid in the pleural cavity occasionally were fully developed during the first 24 to 48 hours; but in most cases were not distinct until the third or fourth day and increased during the first week.

TEMPERATURE

The temperature curve bore no relation to the gravity of the case in most instances.

Cases of insidious onset and those developing after prolonged illness with measles, purulent otitis media, or pneumonia usually ran an evening temperature of between 101° and 103° with morning remissions of 1° to 2°, the remissions becoming greater, even to 96° and the exacerbations to 104° or 105° toward the termination of fatal cases.

When the onset was sudden or gradual the temperature curve was similar to that above described in about half the cases, especially those terminating favorably. In some of the latter and most of the fatal cases, toward the end, the evening temperature often reached 104° to 105° and dropped from 3° to 4° in the morning, an exaggerated "pump handle" curve.

An irregularity of temperature curve suggestive of sepsis was apparent in nearly all cases; usually slight, but in some conspicuous.

The temperature had no characteristic that would distinguish it as related to empyema, in contradistinction to other infections with foci of suppuration.

In connection with these cases, one sign of value in the observation of all patients infected with streptococci was repeatedly observed: in cases of localized streptococcus infection with little or no fever, trivial or no symptoms and slight signs (in this series usually tonsillitis, bronchitis, pneumonia and otitis media, in the stage of recovery), a sudden rise of temperature to 104° or 105°, with or without malaise or headache, indicates a new focus of infection 24 to 48 hours before other symptoms or signs indicated it.

CHARACTER AND LOCATION OF EXUDATE

Repeated paracentesis and observation at time of operation disclosed the following:

1. Cases aspirated early, and repeatedly, frequently yielded clear serous fluid the first one, two, or three days and thereafter cloudy serofibrinous, seropurulent, or purulent fluid.

2. The fluid aspirated in several cases immediately before operation was cloudy serous, and when the pleura was opened, due to the agitation of the fluid, frank pus was obtained.

3. In a considerable number of cases the first, less often the second, and in a few cases the third, evacuation by aspiration, at daily intervals, yielded apparently sterile fluid and the next fluid withdrawn showed streptococci.

4. Even when the physical signs indicated fluid, frequently no exudate was obtained the first time a needle was introduced; often three or four punctures were made before obtaining fluid; similar, though less numerous failures, accompanied the use of trocar and canula.

5. In a number of cases the exudate was sacculated and in two fatal cases the empyema was bilateral.

COMPLICATIONS

Pericarditis with effusion developed in the course of the disease in 27 fatal cases. It was detected antemortem twice by the physical signs and in two other cases was indicated by X-ray.

Peritonitis occurred early in four cases. Diffused peritonitis developed late in 12 other fatal cases.

Pneumonia, usually broncho, developed before the end in nearly all fatal cases.

Bronchitis, in some cases slight, in some cases severe, was present throughout the course of the disease in nearly all cases.

Postmortem findings indicate that grave pathological changes in the liver, spleen, and kidneys were frequent complications; but such were not detected during the progress of the disease.

Diphtheria. During the period that empyema occurred, 30 per cent of all patients admitted to the hospital were diphtheria carriers (throat or nose) and true diphtheria was a frequent occurrence. Following operations 58 of the patients, usually the more severely ill, at one time or another carried diphtheria bacilli in the nose or throat. Two of the cases were complicated by tonsillar diphtheria. Diphtheria of the wound complicated 5 cases, 2 of which were fatal.

DURATION, MORTALITY, AND MORBIDITY

Duration. One hundred and fifteen cases have been completed to date. Four cases not operated upon that terminated in recovery had an average duration of about 30 days.

Intercostal incision and drainage were made in 3 cases; 1 patient recovered who was operated upon 28 days after the onset of the disease, the other was discharged from the hospital 52 days after operation, 2 were ill 8 days before operation, 1 died 9, and one 40 days after operation.

Rib resection and drainage were done in 101 cases and 69 terminated in recovery. In these the average duration before operation was 22 days; after operation 56 days. In the fatal cases the average duration of the disease before operation was 16 days and after operation 13 days.

MORTALITY

	Per Cent
Total mortality	48.6
Mortality, not operated	91.0
Mortality, intercostal, incision and drainage	66.66
Mortality, rib resection and drainage	31.8

The right side was more frequently affected than the left, 85 to 60, and the mortality was greater among right-sided cases than left, 67 to 36 per cent.

Two were bilateral cases; one was operated upon, but both died.

Mortality of cases operated upon, according to character of exudate, was as follows:

	Per Cent
Serous	74
Seropurulent	80.2
Purulent	58

In 101 cases operated upon there was a note made showing how many days after the development of lung symptoms, e. g., bronchitis, broncho or lobar pneumonia, pus was found in the chest. There were in

			Per Cent
1 to 5 days,	25 cases with	12 deaths,	mortality 48
6 to 10 days,	24 cases with	6 deaths,	mortality 33.3
11 to 15 days,	17 cases with	5 deaths,	mortality 29.4
16 to 20 days,	13 cases with	3 deaths,	mortality 23
21 to 25 days,	5 cases with	2 deaths,	mortality 40
31 to 35 days,	3 cases with	1 death,	mortality 33.3
36 to 40 days,	2 cases with	0 death,	mortality 00
40 plus days,	6 cases with	0 death,	mortality 00

With the exception of from 21 to 30 days in which time there were but 11 cases, the mortality was progressively higher in those developing empyema early in the disease.

Of those who died following operation,

2 died between 1 and 5 days after operation.
10 died between 6 and 10 days after operation.
3 died between 11 and 15 days after operation.
4 died between 16 and 20 days after operation.
1 died between 20 and 25 days after operation.
1 died between 26 and 30 days after operation.
4 died between 30 plus days after operation.

The average number of days after operation was 14.8. Of those who recovered and were discharged from the hospital,

3 left between 20 and 30 days.
7 left between 31 and 40 days.
7 left between 41 and 50 days.
4 left between 51 and 60 days.
3 left between 61 and 70 days.
2 left between 71 and 80 days.
4 left between 81 and 90 days.
0 left between 91 and 100 days.
0 left between 101 and 110 days.
2 left between 111 and 120 days.
1 left between 121 plus days.

The average time of discharge following operation was 58.3 days. There are 35 cases remaining in the hospital.

Morbidity. Convalescence is more than three months in duration in all cases, and not one has been found with full restoration to health. Of those finally released from the hospital, 8 have been readmitted with recurrences and not one has been able to resume a full duty status; it is very doubtful if any of these patients will become fit for a full performance of duty as a soldier within 6 months after operation and the majority undoubtedly never will.

DIAGNOSIS

In primary empyema (not preceded by other disease) changes in physical signs, symptoms and blood count, disclose the diagnosis. About half the cases were secondary to pneumonia, 59 complicating primary lobar pneumonia, 17 primary bronchopneumonia, 14 lobar pneumonia secondary to other diseases, 18 bronchopneumonia secondary to other diseases. In this important group we failed to detect the presence of fluid by physical signs in about one-third of the cases, and white cell counts had no differential diagnostic value.

Paracentesis was deceptive when a fine needle and syringe was used. Single punctures with needle or trocar and cannula were also misleading.

By making multiple punctures with trocar and cannula the presence and character of the fluid was discovered in over 80 cases.

X-ray plates distinctly showed the presence of fluid in all but 6 cases submitted to this form of investigation. In the 6 exceptional cases the plates were suggestive but not conclusive.

In practically all cases differential diagnosis of empyema from pleurisy with effusion required aspiration of fluid and bacteriological examination. Whenever clear or cloudy serous fluid contained streptococci, 1 to 3 days later the exudate was typical pus. Frequently when the first fluid obtained was serous and showed no bacteria, a later specimen showed streptococci.

From our findings in these cases we believe early diagnosis, essential to best results, requires:

1. Careful physical examination of chest daily in all cases of streptococcus infection regardless of its location.

2. Immediate and repeated X-ray examination of chest when severe continuous pain is referred to chest, and though other symptoms and signs suggest disease elsewhere and in all cases of pneumonia of prolonged and otherwise atypical course.

3. Exploratory punctures with medium-sized trocar and cannula should be made in every case and repeated in every case several times if fluid is not obtained.

4. Total differential leucocyte counts and thorough bacteriological investigation of fluid withdrawn.

ETIOLOGY

Measles, *per se*, does not appear to be a predisposing factor. Out of more than 1,600 cases of measles, without other complications, there were only 9 cases of empyema. In 224 complicated cases of measles the most frequent complication was pneumonia; lobar, 59, broncho, 14.

The most favorable subjects for the development of pleurisy with effusion and empyema were those who suffered with pneumonia complicating or following measles. Pleurisy with effusion developed in 21 and empyema in 11 of 59 cases of lobar pneumonia complicating or following measles; effusion in 8, and empyema in 1 of the bronchopneumonia following measles. From this it appears that measles is more frequently followed by pleurisy with effusion than by empyema. That empyema is more apt to follow pneumonia than measles is apparent when we compare its incidence in primary pneumonia, 11 per cent in 323 cases while in 1,600 cases of measles the incidence is 0.56 per cent.

The most important predisposing cause, and it would seem almost an essential factor in the occurrence of the majority of cases of empyema, is a marked reduction in the normal immunity or resistance to disease, from any cause, conspicuous among which have been prolonged illness, undue exposure to cold and unusual fatigue.

Direct evidence as to the atrium of infection or route by which streptococci gained access to the pleura, was not found but it appeared that the organism first entered the body through the respiratory tract.

There is no evidence that empyema directly resulted from transmission of infection from one person to another.

TREATMENT

This disease was not influenced by any form of medication and the conditions under which serum treatment was administered, subcutaneous, intravenous, and intrathoracic, permit no conclusions, but results were not encouraging.

Absolute rest throughout the disease should be very efficacious and is now one of our most studiously observed practices in all cases of streptococcus infection. This, with maximum nutrition, early recognition of empyema and speedy delivery of patient to the surgeon, is the most the physician can do.

A very small group of milder cases of empyema tend to spontaneous recovery and progress to a favorable termination without medication, operation, or treatment other than nursing. Another small group recovers after repeated aspiration.

It was early discovered that attempts to differentiate cases of the above character from those requiring resection and drainage were futile and disastrous, and that best results require resection and drainage.

Later it became evident that the earlier in the disease this operation is performed the better are the patient's chances for recovery.

When a case is diagnosed empyema by the medical service and the condition confirmed by the laboratory, these cases are transferred to the surgical service and drainage of the chest immediately established. Two surgical wards were assigned for empyema cases exclusively; all diphtheria carriers being isolated in one ward. In this carrier ward, beds were separated by sheets, and ward attendants and ambulant patients wore masks.

The operation of choice in this series of 104 cases was rib resection, seventh or eighth preferably in the postaxillary line, or farther posterior, so that when the patient is lying on his back the drainage is dependant. A few cases have required drainage farther anterior or where pus has been found with a needle.

One case was an inter-lobar accumulation, the others with few exceptions were typical pleural accumulations, a few sacculated by fibrinous adhesions. We have found at operation none of the "substernal" pockets described in the Camp Funston report.

Thoracotomy was not considered a desirable operation for the reason that drainage was not as free as in a rib resection. It was more difficult to retain the tubes in place and they have a tendency to close too rapidly. Often the ribs are so close together that the insertion of a tube is difficult.

ANÆSTHETIC

It would seem that the anæsthetic used had little if any effect upon the ultimate outcome of the case. Ether was used in 76 cases; 25 of these died later, a mortality of 32.9 per cent. Nitrous oxide and oxygen were used 18 times; 6 died later, a mortality of 33.33 per cent. Cocaine anæsthesia was used but 4 times, with 2 deaths, a mortality of 50 per cent. Chloroform was considered a more dangerous anæsthetic, so was used but 3 times, with 1 death, mortality 33.33 per cent. In 3 cases there was no record of the anæsthetic used, with 1 death in this series.

Nitrous oxide was considered the most satisfactory, in that the patients were quickly anæsthetized, but little gas was necessary and the recovery prompt, with the patient in excellent condition. Caution is necessary, however, as the patients easily become cyanotic due to the fact that a large part of the lung tissue is not functionating.

Ether is satisfactory and safe. Lung cases require but a small amount of anæsthetic to maintain complete anæsthesia (2.1 ounces was the average amount used for all operations). The average length of time for all rib resections was 7 minutes and 15 seconds. This small amount of ether surely cannot be considered as deleterious, and was considered preferable to a local anæsthetic, with which there was always some pain, nervousness, and often restlessness on the table.

Of those who recovered, drainage with rubber tube was maintained for a variable period, averaging 3 weeks, the wound closing about 2 weeks later. A number of cases required reopening as shown by elevation of temperature and fluoroscopic examination. In these the original incision was either incised or forced open with a hæmostat and a tube inserted, or a rib resection was done posteriorly better to drain a cavity.

Carrel-Dakin solution was used in 35 cases from 4 to 6 weeks. The concensus of opinion here is that it is not beneficial. There was no particular change in the temperature or pulse. Many of the patients complained of cough, which was very annoying. After 2 to 3 weeks' use of the solution there was not a very appreciable change in the bacterial count from the wound. A few of the cases which were closed after a count was made of 5 to the field for 5 days, had to be reopened. The patients were kept in bed and disturbed every 2 hours while they would otherwise be up and around. It was felt that the pressure of the fluid between the lung and the chest wall favored collapse of the lung and increased the size of the cavity as well as causing infection in the dependent portion of the chest by gravity. A series of half the patients in one ward was kept on the solution while the remaining half was not. Those without the Carrel-Dakin solution seemed to improve more rapidly. There was no appreciable diminution of the discharge nor of the odor.

In the after-treatment suction was not used in the chests. The blowing of water from one bottle to another was used and found beneficial. The patients who were able to do so were given careful and systematic setting-up exercises and all were kept out of doors and in the fresh air as much as possible.

LABORATORY STUDIES

Laboratory studies were undertaken with the view of determining the etiological factors concerned in the production of the empyema. Cultures were made from the nose, throat, blood, and pleural exudate. Studies were made of the blood to determine the value of leucocyte and differential counts and whether the presence or absence of agglutinins aided in arriving at a diagnosis or prognosis.

Tonsils and nasopharynx. Cultures from the tonsils and nasopharynx of pneumonia and empyema cases were not systematically studied, but in the course of a survey for meningitis made from January 1, 1918, to March 1, 1918, cultures were taken from the nasopharynx with the result that about 20 per cent of the cultures showed the presence of a hæmolytic streptococcus in apparently normal individuals. The incidence of streptococcus hæmolyticus was most marked during the month of January when certain organizations showed as high as 50 per cent hæmolytic streptococci in their cultures. Cultures were taken from the nasopharynx and tonsils of 36 empyema cases. Agglutination reactions carried out with 9 strains isolated from the tonsils of these cases using sera from empyema cases showed no constant reaction between the strain isolated from a given case and the serum from that same case.

Blood. Blood cultures from 37 cases of empyema showed streptococcus hæmolyticus in 1 case, or 2.7 per cent. This positive culture was obtained about 72 hours before death. Repeated cultures were not made.

Leucocyte Counts	Number	Per Cent
5,000 to 10,000	5	11.1
10,000 to 20,000	26	57.8
20,000 to 30,000	10	22.2
30,000 to 50,000	4	8.0
Total	45	100.0

Differential Counts	Number	Per Cent
60 to 70 polymorphonuclear cells	7	16.6
70 to 80 polymorphonuclear cells	12	28.6
80 to 90 polymorphonuclear cells	19	45.2
90 to 95 polymorphonuclear cells	4	9.6
Total	42	100.0

Of the remaining forms of leucocytes nothing noteworthy was found.

Sputum. Of 18 sputa examined from patients, who later developed empyema, 11 or 61.1 per cent showed streptococci and 7 or 38.9 per cent showed pneumococci of which 2 proved to be type 1. Of the remaining 5 no attempt was made to determine the type.

Urine. Of 60 specimens examined at various stages of the disease, 7 showed the presence of albumin, while 10 showed casts and albumin.

Pleural Exudates.

Character of Fluid	Number	Per Cent
Serous	23	15.5
Seropurulent	83	56.1
Purulent	42	28.4
Total	148	100.0

The serous fluid was obtained in the early stage and was transformed into a seropurulent or purulent later in the course of the disease. The seropurulent or purulent fluid permitted to stand for any length of time soon separated into an amber-colored supernatant layer usually clear or slightly cloudy, and a grayish white layer in the bottom of the tube consisting of fibrin and pus-cells.

Exudates from which pneumococci were recovered were thick, of a grayish white or creamy color and did not show the distinct separation into layers as evidenced by the exudates from hæmolytic streptococci.

Organisms Isolated	Number	Per Cent
Streptococcus hæmolyticus	137	92.5
Pneumococcus, type 1	2	1.4
Pneumococcus, type undetermined	7	4.7
Streptococcus viridans	2	1.4
Total	148	100.0

BACTERIOLOGY

Pneumococcus. The diagnosis was based upon the morphology, bile solubility, inulin fermentation and a greenish zone about the colonies when planted upon blood agar. In two cases type 1 pneumococcus was obtained from the sputum and from the pleural exudate and from the same case. It was noted that hæmolytic streptococci were recovered from these same cases after they had been in the ward with other empyema cases for several days.

Streptococcus viridans. Diagnosis was based upon the characteristic appearance upon blood agar, bile insolubility and nonfermentation of inulin.

Streptococcus hæmolyticus. Studies were made of 58 strains isolated from pleural exudates of empyema cases as to their morphology, hæmolytic properties and inulin fermentation.

Broth. After 24 hours' incubation there was slight clouding of the medium with a fine granular sediment present at the bottom and along the sides of the tube. Microscopic examination revealed a chain of streptococci ranging from 20 to 40 organisms to the chain.

Blood agar. After 8 to 12 hours' incubation a beginning zone of hæmolysis was manifest about the line of inoculation which at the end of 18 to 24 hours was distinct, measuring from 3 to 5 millimeters in diameter; but in some strains the degree of hæmolysis was still more marked, giving rise to a zone measuring about 6 to 8 millimeters in diameter.

Inulin. None of the strains studied fermented inulin after 5 days' incubation.

Of the 148 cases 72 died, a mortality of 48.6 per cent. The organisms found in these cases were:

	Number	Per Cent
Streptococcus hæmolyticus	68	94.4
Pneumococcus, type 1	1	1.4
Pneumococcus, type undetermined	2	2.8
Streptococcus viridans	1	1.4
Total	72	100.0

POSTMORTEM EXAMINATION

Postmortem examinations were made on 50 cases.

Character of Fluid Found at Postmortems	Number	Per Cent
Serous	3	6.0
Seropurulent	39	78.0
Purulent	8	16.0
Total	50	100.0

Adhesions. Adhesions were marked on the affected side in all cases examined and especially so in the cases where drainage had been instituted. Distinct pus pocket formation was most frequently found near the opening in the chest wall. These pockets usually contained small quantities of pus.

When larger pus pockets formed they were usually some distance above or below the drainage opening. Other locations of walled-off pus were as follows: between pericardium and lung 3, substernal 2, between the lobes of lung 2.

Pericarditis.

Character of Fluids	Number	Per Cent
Serous	11	40.7
Seropurulent	14	51.5
Purulent	2	7.8
Total	27	100.0

Peritonitis.

Character of Fluids	Number	Per Cent
Seropurulent	9	75.0
Purulent	3	25.0
Total	12	100.0

It is seen that 12 cases had a general serositis while 15 had only a pericarditis.

Lungs. An extensive bronchopneumonia was noted in 35 cases while in 13 cases the process was not so marked. In 2 cases a lobar pneumonia was found.

Lobular pneumonia, showing the irregular patches of consolidations was found in 35 cases. These consolidated patches were red, elevated and surrounded by small areas of air-constricted tissues. Microscopically a peribronchial infiltration, with polymorphonuclear cells and some round cells, was noted. The alveoli were filled with numerous polymorphonuclear cells and some blood-cells. The interalveolar vessel was markedly congested and small hæmorrhagic areas were scattered throughout the section.

Interstitial pneumonia. In a series of 13 cases a gross appearance of the lung showed a distinct difference from that seen in the lobular pneumonia described. The part involved presented a mosaic appearance produced by thick bands of grayish white connective tissue which surrounded lobules of dark reddish-blue colored collapsed lung tissue.

Microscopic examination shows the alveoli filled with numerous epithelial cells, which are undergoing degeneration, and with polymorphonuclear cells. Peribronchial infiltration with round cells and polymorphonuclear cells were noted as well as interstitial infiltration of the bronchi with round and connective-tissue cells.

The two cases of lobular pneumonia showed the characteristic appearance of that disease.

A well marked peribronchial adenitis was noted in 30 of the 50 cases studied.

Other complications. Multiple abscesses of the spleen were noted in three cases. In three cases occurred well marked hæmolytic jaundice; in one endocarditis and petechial hæmorrhages upon the serous membrane; acute ulceration was noted in two cases.

AGGLUTININS

An attempt was made to determine the presence or absence of specific agglutinins and to ascertain by means of agglutination reaction whether the type coccus isolated was the same in all the cases considered. With that purpose in view cross agglutination experiments were carried out, using 17 strains of hæmolytic streptococci and 41 sera obtained from empyema cases. To each culture was added serum obtained from the same case from which the culture had been isolated.

Of the 17 cultures so studied, 8 strains agglutinated by the patient's serum from whom the cultures were obtained. Nine cultures were not agglutinated by the same serum but by serum from other cases.

Following are the results obtained using 1:20 dilution of the sera from the 41 cases studied and 17 strains of streptococcus hæmolyticus isolated from empyema cases.

1 culture agglutinated by 34 sera.
2 cultures agglutinated by 9 sera.
6 cultures agglutinated by 14 sera.
1 culture agglutinated by 17 sera.
1 culture agglutinated by 10 sera.
1 culture agglutinated by 11 sera.
1 culture agglutinated by 5 sera.
3 cultures agglutinated by 12 sera.
1 culture agglutinated by 16 sera.

The serum obtained from empyema cases showed the following agglutination reactions in dilutions of 1:20.

2 sera agglutinated 0 strains.
8 sera agglutinated 1 strains.
1 sera agglutinated 2 strains.
4 sera agglutinated 3 strains.
1 sera agglutinated 4 strains.
6 sera agglutinated 5 strains.
3 sera agglutinated 6 strains.
1 sera agglutinated 7 strains.
6 sera agglutinated 8 strains.
3 sera agglutinated 9 strains.
2 sera agglutinated 10 strains.
1 sera agglutinated 11 strains.
2 sera agglutinated 14 strains.
1 sera agglutinated 15 strains.

No attempt has been made to immunize animals against each strain of hæmolytic streptococcus recovered.

SUMMARY

1. The high incidence of streptococcus hæmolyticus in the tonsils and nasopharynx of normal individuals during the period when

streptococcic pneumonia and empyema were prevalent was observed.

2. Blood cultures show the presence of organisms late in the disease in grave cases only as a rule. A positive culture is a most unfavorable prognostic sign.

3. The pleural exudate obtained from empyema cases from which hæmolytic streptococcus was recovered showed a distinct difference in its physical characteristics in the majority of cases from the empyema fluid from which the pneumococcus was recovered.

4. The streptococci recovered showed the same morphological and cultural characteristics, but the irregularity of serological reactions does not permit one to draw definite conclusions as to their belonging to the same group.

5. Agglutination reactions with patient's serum is of no diagnostic value because of irregularity of reaction with streptococci.

6. Postmortem findings in cases presenting both pneumonia and empyema caused by streptococci showed in most cases distinct lobular pneumonia; in a number of cases the interstitial form of pneumonia, especially in the cases of patients who had been ill for a long time.

EXTRA-UTERINE PREGNANCY FOLLOWING RESECTION OF THE TUBE AND INSERTION OF CATGUT TO KEEP IT OPEN[1]

By E. HASTINGS TWEEDY, F.R.C.P.I., Dublin, Ireland
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THE specimen which is here described consists of a pregnancy formed in the ampulla of the right tube of a patient who, on two previous occasions, had had this tube resected. Her history is briefly as follows:

Admitted to Steevens Hospital in May, 1915. She was operated upon by abdominal section for fixed retroversion with very firm adhesions which bound the uterus to the intestines. Both tubes were affected. The isthmus of the right tube was occluded by several hard concretions. The diseased portion of the tube was removed and an end-to-end anastomosis was performed. A note in my book at the time suggests the possibility of relapse, because of the extent and density of the adhesions broken down. In August, 1916, she again came under my care in the Rotunda Hospital. She complained of backache, menorrhagia and sterility. The uterus was again retroverted and fixed. The second operation proved easier than the first, for the adhesions were neither so extensive nor so dense. The left tube seemed healthy, but on the right side where the end-to-end anastomosis had previously been done there was no true union. The stumps lay at right angles one to the other and the orifices at both sides were completely closed. The occluded portions were cut away and a piece of chromacized fine catgut was passed through the fimbriated end of the tube and also through the uterine stump into the uterus. The uterine stump was then drawn through the fimbriated extremity and stitched in position. The ampulla thus lay over the uterine stump in the form of a ferrule or cap. The left tube was not interfered with. In February, 1918, the patient returned to the Rotunda Hospital suffering from pain in the side and irregular hæmorrhages. The uterus was again retroverted. On opening the abdomen, some posterior adhesions were easily broken down by touch and the right tube liberated and brought into the wound. Its outer third was swollen into a round tumor about the size of a plum. Its fimbriated extremity was open but much constricted. A probe could easily be passed through the tube into the uterus. It was impossible to say what this plum-shaped lump consisted of and it was deemed advisable to remove it. Dr. Boxwell, who kindly examined the specimen, had no difficulty in declaring it a tubal pregnancy.

A further experience in the treatment of sterility has served to confirm my former estimate that in 50 per cent of women, sterile in spite of curettage, the cause will be found to lie in tubal disease. There is reason to believe that occlusion of the tubes may be present without any apparent abnormality, for I have in mind one woman with apparently normal tubes who became rapidly pregnant for the first time after the tubes had been blown up with air, though, previous to this, she had been

[1] Read before the Section of Obstetrics in the Royal Academy of Medicine in Ireland, February 22, 1918.

twice curetted and had undergone much local treatment without result.

It is rare to find the fallopian tubes diseased throughout their entire lengths: sometimes the ampulla is alone involved, and when it is diseased the ovary almost always shares in the adhesions in which it is embedded. On other occasions the ampulla and isthmus show gross disease; more rarely the isthmus is involved, and contains numerous solid concretions while the ampulla and intra-uterine portions are both free from disease. In whatever situation the disease is found, it is always evident that a complete barrier to conception is present, and no treatment which falls short of the surgical opening of the lumina of the tubes can be of any possible benefit in the relief of sterility.

In respect to operative interference, it must be confessed that salpingectomy as at present practised has yielded very disappointing results; this is entirely due to an imperfect technique, and should not be held as a contra-indication to the operation.

The amputation of the tube with or without top sewing of the raw stump has been in the cases I have had an opportunity of re-examining, invariably followed by complete occlusion at the stump.

Again in the present case, the extremities of the tube were brought together by end-to-end anastomosis, and the two portions were found adhering at right angles, one to the other, with complete closure of both stump orifices.

I have found the fimbriated extremity again closed after previous opening, and I have found the artificially formed os closed. In a case where the ovary was pressed into the split ampulla, the ovary became surrounded with a membrane which covered the mouth of the tubes and prevented ovulation.

Demonstrated failures after recognized devices induced me to adopt the catgut bougie as a means of keeping open the tube lumen. In spite of discouragements from my friends, I have always believed that in this device there is a solution of the difficulty. At first the catgut was applied in a rough and imperfect manner by passing a threaded needle for a certain distance down the fallopian tubes, and then bringing the needle and suture out through its wall. This technique is very faulty and will certainly result in tube occlusion at the site of the sutures' exit. It is impossible to guide an ordinary piece of unthreaded catgut into the tube, and a probe passed down to enlarge the lumen is liable to make for itself a false passage — a very undesirable complication. Chromic gut is stiff and unyielding and I employed it because these properties enabled me to pass it without any extraneous aid.

The critical period for closure of the tubes is comprised within the first three days after operation, while peritoneal exudation is poured out and adhesions are rapidly forming.

It seems certain then that no good object is effected by retardation in absorption of the gut. On the other hand it is probable that the retention of the gut for many days in the tubes is harmful. The ciliated epithelium can hardly escape injury, and the irritative effect which it must exercise on the muscle layers of the tubes will be still more important. It seems to me certain that these muscle bundles by their peristaltic contractions must be the force which enables the ovum to reach the uterus and I feel sure that an arrest of their peristaltic wave is an important factor in the occurrence of tubal pregnancy.

After many unsuccessful efforts I discovered a plan which enables me to place ordinary soft catgut in the tube. I thread a long fine Glovers' needle, permitting the catgut to pass the eye by only one-quarter of an inch. The blunt side of the needle carrying the ligature is inserted through the lumen of the tube into the uterus or as far down as seems expedient. The thread is then pulled until it is felt to have left the eye, the needle is then gently withdrawn while the gut remains in position.

Silkworm-gut, could it be used, would be free from the fear of exciting a chronic salpingitis but were it employed there must be some method perfected for its removal.

I now possess a long fine probe, eyed at one end, and by its use I am sometimes able to pass the gut into the uterus and out through

its wall. If it were possible to pass it through one layer of iodoform gauze, previously inserted into the uterus, the needle would carry the ligature after it either through the wall of the uterus or better still it might be passed through the lumen of the opposite fallopian tube, and could be pulled out on removal of the gauze.

In many cases it is impossible to bring the fundus of the uterus through the abdominal wound, and unless this were accomplished the needle which I show could not pass through both tubes, but it is always possible to force it through the uterine wall, and there seems little practical objection to this. One end of the gut should be cut flush with the serous wall of the uterus, and the other buried in the substance of its corresponding ovary.

A plan such as this could be tried before the termination of an operation and in the event of its failure, the catgut method would still be available.

The strange features in the case I show are that the tube which had apparently become normal, still failed to function and to permit the passage of spermatozoa, while the artificially dilated tube gave free access to the spermatozoa, but could not transmit the ovum.

Blair Bell has reported a very interesting case where pregnancy followed his removal of the uterine end of the tube and the stitching of its fimbriated end into the cornu of the uterus. His success suggests the importance of making the passage through which the ovum has to pass as short as possible, and this shortening of the tube will enable the gut to be passed through it with greater facility.

It is impossible to trace my hospital cases but in my private work I have seen no woman pregnant after tube resection which involved the removal of the ampulla and my present opinion is that the latter plays a most important rôle in the guiding of the ovum to the uterus.

CONCLUSIÔNS

To summarize my conclusions:

1. Salpingitis with or without apparent occlusion of the tubes, constitutes a very usual cause of sterility.

2. Ordinary tube resection with or without the formation of an artificial os fails in almost every instance to provide a permanent passage to the uterus.

3. Failure to transmit the products of conception may be present in a tube which shows no gross abnormality.

4. The lumen of a tube can with certainty be kept permanently open by the insertion of catgut through it.

5. The shorter the tube is made the less likely will it be that its lumen arrests the passage of the ovum.

6. A loss of peristalsis will cause arrest of the ovum in the tube and predispose to tubal pregnancy.

7. Chromic or iodized catgut which is employed to keep the tube open is a likely cause of salpingitis with consequent loss of peristalsis.

8. The future cure of female sterility is now largely a question of improved technique for it is based on a definite knowledge.

NOTES OF A CASE OF EXTRA-UTERINE PREGNANCY RESULTING AFTER RESECTION OF THE TUBE AND INSERTION OF CATGUT TO KEEP IT OPEN[1]

By BETHEL SOLOMONS, M.D., F.R.C.P.I., Dublin
Gynecologist to Mercer's Hospital

WHEN Dr. Tweedy informed me that he intended to write a paper on tubal pregnancy following resection of the tube with insertion of catgut in the lumen I mentioned to him that I had a similar experience. He suggested that I should read notes of the case which I append:

Mrs. H., age 33, was married 10 years and had had 5 children when she was admitted to Mercers Hospital on August 13, 1917. She complained of menorrhagia, but her chief complaint was that she had not become pregnant for four years. Examination revealed a slightly enlarged retroverted uterus partially mobile with tubal thickening. I recommended operation and on August 14, after a preliminary curettage and perineorrhaphy, I opened the abdomen. It was then found that both tubes and ovaries were bound down by slight adhesions which were soon freed and the tubes were examined. The right tube having been freed was apparently normal and was dilated with air. The left ampullary ostium was absolutely closed; this was opened, the edges were oversewn with catgut, the tube was dilated with air, and a piece of chromic catgut No. 4 was inserted in the lumen. Some but not all of the fimbriæ of the tube were involved in the resection. A modified Gilliam concluded the operation.

On November 17, 1917, Mrs. H. reappeared at the Dispensary. She had missed a period and had then started bleeding. An examination revealed a tumor deep down in the *right* fornix, and tubal pregnancy having been diagnosed she was admitted into hospital. At the operation it was found that the right tube and ovary were normal while in the left tube near the fimbriated extremity was a mass which was deep down in the right lateral fornix where it was felt on bimanual examination. This mass was removed: it proved on pathological examination by Dr. Wigham to be a tubal pregnancy.

The insertion of catgut in the tube to keep it open after resection seemed to me, when I first heard it suggested by Dr. Tweedy to be a most rational procedure and I have adopted it in many cases. I believe its main advantage lies in the fact that it preserves the patency of the tube while the resected portions are raw. I do not believe it is necessary that it should be placed so that it traverses the entire length of the tube through the uterine ostium.

It is difficult to understand why extra-uterine pregnancy resulted in the case that I have reported. It is generally agreed, as noted by Blacker, that the commonest cause of tubal pregnancy is a mechanical interference or a failure of the forces which ordinarily lead to the passage of the ovum into the uterus and that the two factors which predispose to these are (a) a change in the musculature of the tubal wall and (b) a disappearance of the ciliary currents in the tube as a result of changes or shedding of the epithelium. Blacker also states definitely that there is no proof that antiperistaltic action of the tube hinders the passage of the ovum to the cavity. But the general summing up of modern opinion as to the etiology of tubal pregnancy is most unsatisfactory—it is generally due to more than one factor.

It is of note that my patient was apparently suffering from temporary sterility subsequent to a slight degree of sepsis in the previous confinement and it is a matter for argument as to whether the tubal pregnancy was a result of the salpingitis or of the irritation from the chromic gut. Personally I am inclined to favor the idea that salpingitis which is definitely known as a causal factor, though not always present as such was blameworthy.

[1] Discussion of Dr. Tweedy's paper read before the Royal Academy of Medicine of Ireland, February 22, 1918.

INDICATIONS FOR SURGICAL INTERFERENCE IN ULCUS VENTRICULI

And Underlying Factors Influencing Results of the Operation

By M. H. GROSS, M.D., and I. W. HELD, M.D., New York

THERE are still differences of opinion as to when a gastric ulcer should be submitted to surgery. Extremists as to both internal and surgical treatment exist. Some internists even go so far as to claim that practically all gastric ulcers belong to the domain of internal medicine, whereas some surgeons of repute teach that ulcer of the stomach spells surgery. Neither extreme is justifiable. If the surgical result of ulcer were uniformly and lastingly favorable, ulcer of the stomach would be unquestionably a surgical disease. Unfortunately we know this is not the case, and, therefore, before surgical intervention is advised at least definite indications must exist.

In making our indications for operative interference it seems to us best to speak of *relative* and *absolute* indications. To the former belong cases where for one reason or another thorough and efficient medical treatment is impossible, such as the great mass of wage-earners who, because of the demands of their occupations, cannot observe either prolonged dietetic régime or the necessary rest and hygiene required for successful treatment of ulcus ventriculi.

It is not very encouraging that economic conditions should be a determining factor for surgical indication. We are certain that if public hospitals and more private sanatoria, as well as country resorts—with or without spas—were more attentive to dietetic rules, medical treatment would claim ever so many more cures. As it is, however, at present we must content ourselves with advising the most accessible method.

To the *relative* indications also belong the cases where there are distinct signs of excessive fibrous tissue formation around the ulcer, as shown by the niche, if on the lesser curvature, or in the pyloric region, giving rise to progressive pyloric stenosis.

We hold with Boas, Rosenheim, Ewald, Kuttner, Sippy, Hamburger and Einhorn, that these cases should be treated medically. Failure to yield to prolonged and conscientious medical treatment, or tendency to frequent recurrence, or progress of the local lesion as determined by means of X-ray, makes surgery imperative.

We realize that in taking this stand we step on ground subject to criticism from authors who consider every niche or induration a precancerous stage, and hence a surgical disease. Their contentions have been strengthened by the careful and competent studies of Wilson and MacCarty in the Mayo clinic. Following their publications Cole goes so far as to state that X-ray signs of induration on the lesser curvature are to be interpreted as a precancerous state; a statement one may consider at least daring.

From the pathological studies of Orth, Aschhoff, MacCallum, Ewing, and Friedenwald, and our own clinical observations, we are inclined not to accept such extreme views. Clinical observations certainly favor the more conservative view. It is, however, a most perplexing problem for the clinician what course to pursue to be of greatest benefit to the patient, when pathologists of repute disagree.

As stated above, the main support of the claim that cancer often originates on the basis of ulcer is at present at the Mayo clinic supported by the studies of Wilson and MacCarty. These observers, with their unlimited opportunities to study the excised ulcer tissue and occasion to see the earliest microscopical changes of carcinoma, contend that a great number of these specimens show beginning cancer. It is curious that pathologists controlling an immense amount of postmortem material fail to corroborate the findings of Wilson, MacCarty and others. From the clinical standpoint (judging ulcer cases according to their course), the impression is left that the frequency of cancer on the basis of ulcer is not so common.

It seems to us plausible to assume that the reason for the controversy lies in the fact that the school representing the pathological studies of autopsy *in vivo* (Mayo) reports on a different condition from that which bases its deductions on postmortem pathology (Orth, Aschoff, Ewing, etc.).

We feel that the ulcer lesions on the lesser curvature which show microscopical evidence of carcinoma are not cancer on the basis of ulcer, but ulcer on the basis of a beginning cancer. Our reasons for this are the following:

1. The fact that a small ulcer becomes the cause of persistent symptoms not influenced by conscientious treatment, is contrary to the results obtained with ulcer of the stomach. This would tend to prove that the basis of the ulcer is such as to interfere with healing. An ulcer on a previously healthy mucous membrane shows a marked tendency to heal. A progressive ulcer must necessarily be implanted on necrosed degenerative tissue, as would be the case in cancer.

2. The X-ray observation of Levy-Dorn and Ziegler[1] that a stretched-out appearance of any part of the lesser curvature where fluoroscopic and roentgenographic evidence of peristalsis is missing, is significant of early carcinoma of the lesser curvature. Independently Cole[2] observed the same phenomenon by the method of serial roentgenography, interpreting it, however, primarily as a manifestation of indurated ulcer on the lesser curvature.

It is clinically known that small ulcers of the stomach improve very readily, at least temporarily. If symptoms of a small ulcer not detectable to the surgeon's touch persist and necessitate operation, may it not be that it is an ulcer on a beginning cancer?

In fact, Cole in his later publications speaks of the indurated ulcer as a precancerous stage and includes with the indurated ulcer those where no peristalsis is seen on a given area of the lesser curvature, and those where niche formation has resulted. Cole made a valiant effort to diagnose carcinoma of the stomach by X-ray at as early a stage as is only possible by means of a microscope. Enlightened information undoubtedly resulted from Cole's work. His generalization, however, that each niche is a sign of a precancerous state has led to just criticism on the part of the roentgenologist, clinician, and pathologist. It is our opinion that an induration on the lesser curvature with absence of peristalsis is to be considered early carcinoma, and if ulcer is present, it is implanted on the carcinoma. A niche on the other hand is in the vast majority of cases an inflammatory and repair manifestation of an ulcer.

Quite often clinical manifestation of pyloric stenosis, as well as those of a niche, are the result of accompanying inflammatory changes which subside in the course of internal treatment. This explains why marked gastric retention simulating complete closure of the pylorus almost entirely disappears in the course of treatment, and also explains the X-ray observations of Leo Schuller abroad, of Hamburger[3] in Chicago, and Joseph S. Diamond (personal communication)—that a niche may disappear after successful internal treatment. Wilensky (personal communication) from a microscopical study of callous ulcers came to the conclusion that most of these ulcers have started as carcinoma, and that the ulcer is implanted on top of a carcinoma. While we are not in a position to furnish absolute evidence in favor of the above conclusion, we feel that such views may be of benefit from a clinical standpoint.

If a patient presents symptoms of ulcer of the stomach and there is X-ray evidence on the lesser curvature, corresponding to the description of Cole, with no response to medical treatment, we should look upon the condition with great suspicion. More diagnostic efforts, such as the Gluczinski method (diminution of acidity after a Riegel meal), the Wolf-Junghaus test, etc., should be applied in order to arrive at a positive conclusion. When in doubt the patient should be given the benefit of surgical interference. Such cases would really represent early stages of carcinoma and may respond successfully to operation.

As to extensive callous ulcers on the lesser

[1] Med. Klin., 1913.

[2] X-ray diagnosis of indurated gastric ulcer. Am. J. Roentgenol., 1915, Nov.

[3] Am. J. M. Sc., 1918, Feb., 204.

curvature with adhesions to the adjacent organs, we still adhere to the belief, based on the exact microscopical studies of Ewing, MacCallum and others, that the implantation of carcinoma is the exception. With reference to their yielding to medical treatment, we agree with Schuller, Hamburger and others, that the fear that carcinoma is implanted is not justifiable, and that medical treatment may be tried.

There are other cases of ulcer of the stomach where the symptoms are not so much due to ulcer proper, but to its consequences; we refer to instances where adhesions to the pancreas give rise to intermittent diarrhœa and creatinorrhœic and fatty stools; or adhesions of the stomach to the surrounding viscera interfere with the motility of the stomach, giving rise to fermentation and distention. Surgical interference in such cases is seldom successful. Prolonged medical treatment is advised, and surgery only as an *ultima ratio*.

The *absolute* indications for surgical interference are:

1. Cases in which, notwithstanding prolonged medical treatment, occult blood persists, causing a progressive decline in the health of the patient. Such cases must be operated upon without delay for two reasons: because, as first pointed out by Boas, the persistence of occult blood and its most common accompaniment—gradual reduction or even disappearance of free acid—may mean carcinoma; also, even without carcinoma the secondary anæmia prevents the healing of the ulcer, and makes medical treatment unsuccessful.

2. Cases in which hæmatemesis is repeated notwithstanding appropriate care, operation should be performed if possible during the free interval.

3. Cases in which the history of one or more attacks of excruciating epigastric pain with collapse manifestations indicate threatened perforations, which can now be verified by the X-ray finding of penetrating ulcer.

4. Acute gastric perforation. The sooner the operation is performed the greater the chances of recovery.

5. Complete pyloric stenosis.

6. Organic hour-glass contraction.

7. Cases in which, in addition to the ulcer, there is co-existent, chronic appendicitis or disease of the bile passages, with or without stones.

OPERATIONS, OBJECT, ULTIMATE RESULTS

It is known that surgical operation does not remove the etiological factor of the disease and only in exceptional cases does it do away with the pathological seat. This is the reason why Friedenwald and Baetsjer[1] must be credited with foresight in having united medical and surgical treatment of gastric ulcer. In their article they correctly point out the necessity of prolonged postoperative and appropriate dietetic treatment, in order to achieve lasting, favorable results.

The uniform dietetic measures, however, as laid down by these authors cannot, in our opinion, hold good in every case. We believe, as will be shown later, that the disturbed gastric function, if present after an operation for gastric ulcer, results from varied causes and hence the reinstatement of proper function has to be directed according to the underlying causes, if demonstrable.

Gastro-enterostomy. The operation first performed for ulcus ventriculi, if causing pyloric stenosis, was anterior gastro-enterostomy.[2] This was later replaced in the majority of cases by posterior gastro-enterostomy.

Numerous experimental and clinical studies related to the favorable effects of gastro-enterostomy have until recently been attributed to the following factors: drainage; regurgitation of intestinal juice—thereby reducing acidity: decrease in total chlorides.[3] It would be utterly impossible to do justice to the literature that has been piled up within the last few years on the subject of gastric surgery in ulcus ventriculi in general, and gastro-enterostomy in particular. We shall, therefore, discuss only such experimental data of physiologist and clinician as seem to have established permanency in their relation to end-results.

[1] Am. J. M. Sc., 1913, Oct.
[2] Woelfler. Centralbl. f. Chir., 1881, p. 705.
[3] Peterson. Surg., Gynec. & Obst., 1914, xviii, 423.

Influence of drainage on gastro-enterostomy. The favorable results obtained by this operation are attributed to the fact that the stomach is converted into a drainage tube, so that the ingested food merely drops out from the stomach into the jejunum, thereby sparing the stomach.

It was Cannon, and later Cannon and Blake, who demonstrated experimentally on animals that the theory of the stomach representing a drainage tube after gastro-enterostomy is incorrect. They showed that, as in a normal stomach, the mode of filling, peristalsis, and tendency of the food to be churned and passed through the pylorus, are identical. Through the new stoma the food passes only intermittently and in the course of time most of it will pass through the pylorus. These authors also found that if the pylorus is excluded it reopens within a short time and the food passes again by that way.

Since the food undergoes chymification in the sinus-pylorus region, Cannon advised performing the gastro-enterostomy near the pylorus. It is important to note the findings of Cannon that whether the food passes all through the stoma or through both openings depends on the quality of the food. If starch fluid was fed to a dog after a gastro-enterostomy all of it passed through the stoma, whereas if salmon was given it was seen first to reach the pylorus, and the passage of the food took place through both openings. The experimental studies of Cannon and his co-worker are very enlightening, and of great value in postoperative dietetic treatment.

However, we cannot apply fully Cannon's findings on a healthy animal to the gastro-enterostomy in a diseased stomach. In the latter case, due to the disturbed function preceding gastro-enterostomy, the effects of the new stoma are necessarily different. But we must adhere to the physiological principles laid down by Cannon and his co-workers pertaining to gastro-enterostomy; namely, that permanent benefit is not necessarily achieved by drainage. Good results are only possible when all functions of the stomach (chymification, motility, etc.) are re-established. Soon after the operation drainage is a beneficial factor. It serves to divert the food from the ulcerated area and hastens the emptying of the stomach thereby minimizing secretions; eventually, after the ulcer is healed, or the accompanying inflammatory changes, if present, have subsided, the normal function of the stomach should be re-established.

What is true of the beneficial effect of drainage in gastro-enterostomy is also true of the neutralizing effect of the intestinal juice on the acidity of the stomach. For a time after the operation, as long as the irritative effect of the ulcer on the pylorus exists, the regurgitation through the new stoma is essential. With healing of the ulcer and the reinstating of the normal function of the pylorus, regurgitation through the new stoma should to a great extent disappear, as the neutralization can well be accomplished by the duodenal juice by way of the pylorus. Kocher[1] even advocated gastroduodenostomy in order to accomplish the neutralizing effect immediately after the operation by way of the duodenum.

The lack of uniformly good results after gastro-enterostomy, in the absence of extragastric complication, has led numerous investigators to study the effects of the operation from the experimental and clinical standpoint. It is impossible to list the vast amount of literature on the subject. The most valuable contributions are those of Peterson[2], Leo Schuller[3], Faulhaber and Redevitz[4], Schmieden, Ehrmann and Ehrenreich[5], Balfour[6], Wilensky and Wilensky and Crohn[7], Katzenstein[8], Joselin[9], Kautsch[10], A. A. Berg[11], Steward and Barber[12], Warren[13], Johannes Schultz[14], Dagew[15], Jacobson and J. T. Murphy[16].

[1] Med. u. s. Op. 1909, xc, 860.
[2] Peterson. Loc cit.
[3] Schuller. Loc cit.
[4] Faulhaber and Redevitz. Med. Klin., 1914, p. 630 and Med. u. s. Opr., vol. xxviii, No 1.
[5] Schmieden, Ehrmann and Ehrenreich. Med. u. s. Opr., 1913.
[6] Balfour. J. Am. M. Ass., 1915.
[7] Wilensky, and Wilensky and Crohn. Am. J. M. Sc., 1917; Ann. Surg., Phila. 1917, June; J. Am. M. Ass., 1917, March.
[8] Katzenstein. Deutsche med. Wchnschr., 1907, January 17.
[9] Joselin. Berl. klin. Wchnschr., 1897, No. 48.
[10] Kautsch. Mitt. a. d. Grenz. d. Med. u. Chir., 1898, iv, 347.
[11] Berg. J. Am. M. Ass., 1913, lx, 881.
[12] Steward and Barber. Ann. Surg. Phila., 1916, lxiv, 527.
[13] Warren. Boston. M. & S. J., 1899, lxxxix, No. 13.
[14] Schultz, Johannes. Mitt. a. d. grenz. d. Med. a. Chir., 1903, p. 20
[15] Dagew. Ibid. 1913, xxvi, 176.
[16] Jacobson and Murphy. J. Am. M. Ass., 1916, Oct. 28.

These authors have rightly laid their main stress on the kind of operation and its effect on the functions of the stomach. Most of them agree that whatever operation is performed, in the course of time the secretions, shape, size, peristalsis and time of emptying return very much to normal. Leo Schuller was the first who confirmed on human beings after gastro-enterostomy the work of Cannon, that the chymification of the food continues in the pylorus as it would without a gastro-enterostomy, and that where the food passes the pylorus the new stoma functionates less. According to Schuller and others this fact is a disadvantage and some have therefore advocated larger openings at more dependable points. Others (A. A. Berg) do pyloric exclusion in order to facilitate the passage of the food through the new stoma only. We are of the opinion that the tendency of the pylorus to begin functionating again is an advantage.

Leo Schuller brought out an important point, unfortunately not as yet generally recognized, that in florid ulcer a postoperative ulcer cure is essential. He also showed that the postoperative results are not always lastingly favorable because atony of the stomach persists.

The latest work on postoperative results is that by Wilensky and Crohn. They studied the secretory and motor phenomena; the former by means of the fractional method, the latter by X-ray. The tone of the stomach was observed by means of the graphic method of Carlson. They agree with the findings of other authors, that after a gastro-enterostomy there is regurgitation of intestinal juice into the stomach, influencing the acidity; they also find that motility is rather moderately hastened, or at least normal. In these studies they attempted to trace the occurrence of symptoms after gastro-enterostomy to disturbance of the secretory and motor processes.

Of all their findings it seems to us that the most important is the one concerning the tone of the stomach. Independently of Schuller they found that a good tone is an important deciding factor in the lasting favorable results after a gastro-enterostomy, and their deductions are most convincing.

From the point of view of the internist, it seems to us that the results of gastro-enterostomy are dependent, first, on the seat of the ulcer, and second, the tone of the stomach before the operation.

A pyloric ulcer giving rise to organic stenosis has, as is well known, two stages; the compensatory stage and that of a broken compensation. During both stages the delay in the emptying of the stomach is a pronounced phenomenon and responsible for symptoms. The difference is, however, that in the compensated state the mechanical gastric digestion is excessive, as manifested by the large quantity of secretion and overactive peristalsis. Food which cannot be acted upon by gastric secretion is practically liquefied before some of it passes in the form of a thin stream through the narrow pylorus into the intestines. The tendency of such a stomach to empty its contents is manifested by the regurgitation of sour fluid (water brash) or vomiting of great masses of food that could not undergo chymification or liquefaction in the stomach. Evidently the associated pylorospasm prevents the sour chyme from passing the ulcer area. Therefore a new opening (posterior gastro-enterostomy) is, as it were, almost wished for by the stomach. In reality this corresponds to practical results. Ever since gastro-enterostomy has been performed for ulcus ventriculi the most favorable results are obtained in benign pyloric stenosis. In perfectly successful cases the food leaves the stomach through the new stoma exclusively shortly after operation by drainage, and later in small, successive portions accompanied by normal peristalsis. Passage of food through both openings begins when the florid ulcer has come to a standstill, so that the resulting pylorospasm no longer exists.

How much of the food will pass the pylorus in the course of time depends upon how much of the stenosis was primarily due to fibrous tissue formation, and how much to associated inflammatory changes and pylorospasm. That the food has a tendency to pass through the pylorus, notwithstanding the existence of a new opening, is evidenced by the fact that even a pyloric exclusion in time is overcome.

In order however to achieve lasting results, the dietetic and medicinal régime must be carried out for four to six weeks after the gastro-enterostomy as carefully as if no operation had been performed. For at least two years longer, spicy and irritating foods must be avoided.

In case symptoms of ulcus ventriculi recur within a short time after the operation, notwithstanding the care outlined above, the possibility of gastrojejunal ulcer (ulcer at the point of operation) must be borne in mind. This type of ulcer, its diagnosis and treatment, will be discussed below.

Sometimes symptoms of ulcer with marked hyperacidity and gastric stasis occur periodically after a gastro-enterostomy. It is most common in individuals who ignore dietetic rules. It would be very erroneous to attribute the symptoms to a closure of the new stoma and advise operation again. It should, however, be remembered that the hyperacidity often causes spasm of the new opening, as first pointed out by Zweig.[1] We believe that this spasm serves a protective purpose so as to prevent the acid chyme reaching the jejunum direct. Proof that this is plausible lies in the fact that a successful cure, with the subsidence of hyperacidity, reinstates the function of the new stoma.

Rational treatment consists in lavage of the stomach with an alkaline solution (natr. bic. 10 per cent solution, 1 pint, temp. 100°) every morning for four to five days. Also frequent feeding with predominating fat diet of a low melting point—milk with sweet cream, thin cereals, with butter, yolks of eggs, and a tablespoon of olive oil, *t. i. d.*) This feeding has proved effective, as demonstrated experimentally by Katzenstein.[2] He showed that the acidity after a gastro-enterostomy is reduced by the regurgitated intestinal secretion and bile. These are in turn much greater in quantity and more rapidly brought on by a fat-rich diet. Katzenstein showed on animals that with a fat-poor diet the regurgitation of intestinal secretion occurs after an hour and a half; with a fat-rich diet within half an hour.

A rarer cause of gastric stagnation after gastro-enterostomy may be the loss of the tone of the gastric musculature. This condition is accessible to diagnosis by means of the X-ray. Lavage with small quantities (250 cubic centimeters) of an alkaline solution every morning for one week, rest in bed, and a semi-solid nutritious diet during frequent intervals, will bring about favorable results.

A still rarer complication in this form of benign stenosis after gastro-enterostomy is the so-called vicious circle. Persistent regurgitant vomiting after gastro-enterostomy, containing more or less bile and not controlled by lavage, is designated as the vicious circle. Moynihan[3] classifies four varieties of misdirected current, any one of which would bring about a vicious circle:

1. Regurgitation of duodenal contents through the pylorus.
2. Escape of fluids from the stomach into the afferent loop.
3. Escape of fluids from the afferent loop into the stomach (the most frequent and grave variety).
4. Regurgitation of the contents of the afferent loop into the stomach.

As to the causes of regurgitant vomiting Shlumsky[4] considers the following:

1. Formation of a spur; this is the most frequent and is caused by a sharp kink between the two links at the point of junction.
2. Jejunal displacement may cause a kink at the duodenojejunal junction, causing duodenal obstruction.
3. The mucous membrane of the stomach may form large pouting valves thereby obstructing the afferent opening.
4. Closure of the anastomotic opening on account of an improperly applied stitch.
5. Compression of the afferent loop by the colon (Doyen).
6. Constriction of the afferent loop by an opening in the transverse mesocolon (Stendel and Czerny).
7. Antiperistalsis of the implanted jejunum (Woelfler).

[1] Arch. f. Verdauungskr., 1913, xix, 740.
[2] Deutsche med. Wchnschr., 1907, Jan. 17-24.
[3] Abdominal Operations. Philadelphia: 1906, p. 201.
[4] Beitr. z. klin. Chir., 1898, xx, 231.

Carman and Miller[1] studied a number of regurgitant vomiting cases by X-ray after gastro-enterostomy. The time that had elapsed since operation ranged from one month to ten years, with an average of three years.

It is noteworthy that in some cases of regurgitant vomiting, a second surgical exploration failed to reveal an adequate cause, especially where a gastro-enterostomy was performed to relieve symptoms without a demonstrable lesion of the stomach. In most of the cases they could find no roentgenological evidence to account for the symptoms. In ten cases there were X-ray signs of great disturbance due mainly to obstruction, as shown by the retention of the six-hour meal, large sized stomach, failure of the barium to pass through the stoma, and hyperperistalsis.

At re-operation various conditions were found. In three instances adhesions were the cause of obstruction; one showed a stricture produced by contraction of the opening through the gastrocolic omentum, and in another case the gastro-enterostomy had been made on a long loop which had kinked. If the continuous vomiting is due, as shown above, to organic obstruction, quick surgical intervention should be resorted to. Deaver[2] attributes all cases of so-called vicious circle to mechanical interference and advises operation at once.

BENIGN PYLORIC STENOSIS WITH ATONY

Cases of benign pyloric stenosis due to ulcer accompanied by a high degree of atony of the stomach after gastro-enterostomy do not show as high a percentage of favorable results as pyloric stenosis with good tone of the stomach. This corresponds well with the observations made by Carter.[3]

It has already been mentioned that the work of Leo Schuller and that of Wilensky and Crohn point to the fact that a diminished or lost tone of the gastric musculature is often responsible for failure to get satisfactory results after a gastro-enterostomy. Our own clinical observations are fully in accord with the studies of these authors.

[1] Philadelphia, 1917, p. 33.
[2] N. Y. St. J. Med., 1917, Dec.
[3] Am. J. M. Sc., 1917, Dec., 851.

The causes of postoperative disturbances are manifold. Shortly after the operation the so-called vicious circle is much more common in the atonic stenosed stomach. In other cases the immediate postoperative results are favorable; only when the patient begins to partake of a more or less liberal diet does recurrence of symptoms set in. These are mainly due to stagnation, hypersecretion, hyperacidity, and food residues. The X-ray reveals a large-sized atonic stomach, where but very little food forces itself through the new stoma during protracted intervals. This indicates that the function of the new stoma is interfered with by spasm. Such findings are often interpreted as being due to a technical fault of the surgeon, and operation is advised. Frequent negative surgical findings in such cases ought to teach us that the cause of the delay in the emptying may be the spasm of the stoma, due to hyperacidity.

If, upon recurrence of symptoms, the patient again undergoes an ulcus cure, initiated by a few gastric lavages, and the diet for an indefinite length of time is of a well-prepared, nourishing, non-irritable nature, complete comfort will result. If the symptoms are ignored and dietetic errors indifferently committed, the acid chyme reaching the jejunum may lead to a jejunal ulcer.

In other cases the lack of satisfactory results after a gastro-enterostomy in an atonic stomach may be due to the fact that the stomach has become a persistent drainage tube. In such a stomach gastric secretions gradually diminish and finally even disappear, because the stimulus of the food is missing when the stomach serves only as a passageway.

Another factor tending to reduce acidity in these cases is the regurgitation of excessive intestinal juice into the stomach. This is because the food, crowding the jejunum, overstimulates its secretions and at the same time increases the tone of that part of the bowel. Thus we see again that drainage and regurgitation of intestinal juice into the stomach, so beneficial shortly after gastro-enterostomy, become sources of discomfort when persistent. The symptoms, due to irritation of the small intestine, consists in abdominal cramp, distention, sensation of

fullness, nausea and vomiting, and often there is also a secondary colitis. Notwithstanding that the food is seen to leave the stomach in a continuous stream, marked delay in emptying is encountered. This is because the overcrowded, small intestine prevents the emptying of the stomach mechanically and by reflex. In these cases the stomach always contains large quantities of intestinal juice and bile, especially an hour or two after meals. This may be explained by the physiological observations of Alvarez,[1] that the higher tone in the small intestine causes regurgitation of its contents into the viscus of diminished tone, namely, the stomach.

In order to achieve favorable results it is of the utmost importance to treat these postoperative cases appropriately. Here the guiding therapeutic principles are the lost tone of the stomach and its perverted secretions. Because of the diminished tone the food should be given in such form as not to necessitate gastric chymification and digestion. Best for that purpose are fats at a low melting point (cream, butter, yolk of egg) and finely prepared carbohydrates in the form of cereals and toast. When the patient tolerates these foodstuffs well proteins may be introduced in the form of egg-white, cream cheese, and the vegetable proteins (beans, peas, spinach in purée form); later, meats, scraped or chopped, and cooked fruit are added to the diet.

It must be emphatically stated that while the food given should be of a quality substantial enough to cause an increase in the general tone of the body, quantity and time of feeding must always be so individualized and guarded as not to overburden the stomach. By such method the tone of the stomach may gradually be re-established and regurgitation of intestinal juice prevented, thereby avoiding pathological neutralization of the gastric secretions.

Great caution is to be exercised when even the slightest symptoms recur. The cause should at once be determined and if the loss of tone and regurgitation of the intestinal juice prove to be the source, treatment as outlined above should be instituted. In some cases regurgitation can only be controlled by gastric lavage at beginning of treatment.

As to whether a pyloric exclusion, in addition to the gastro-enterostomy in cases of pyloric ulcer is the preferable procedure, opinions differ. Some surgeons, especially A. A. Berg, hold that the exclusion is almost essential to a lasting favorable outcome. Others, headed by Kocher, are of the opinion that not only is an exclusion harmful, but it is a drawback because it interferes with the regurgitation of duodenal contents. Another objection to pyloric exclusion arose when the X-ray demonstrated that notwithstanding the pyloric exclusion, patency is re-established in the course of time, a finding confirming Cannon's experimental work on animals. From a physiological standpoint it seems to us that nature's effort to heal the ulcer keeps the pylorus closed until the ulcer is healed and until then the new stoma serves as the sole exit for the food without as well as with pyloric exclusion.

We believe, however, that we are justified in suggesting the following: cases of pyloric stenosis, if the stomach is in a compensatory state, are the ones to be benefited by a pyloric exclusion. While it is true that pylorospasm is nature's pyloric exclusion, it may be reasonably assumed that the pathological hypercontractility of the compensated stomach of benign stenosis may still be a factor for some time after a gastro-enterostomy in forcing acid chyme through the pylorus and prevent healing of the ulcer. Pyloric exclusion obviates such a possibility until the ulcer heals. The good tone of the stomach eventually overcomes the exclusion, and the passage of food through the old opening is made possible. In the atonic stomach, on the other hand, pyloric exclusion ought to be unnecessary, and for beneficial effects may be even a disadvantage, because the weakened tone of the stomach may never be so restored as to overcome the exclusion, and drainage may be a persistent factor. H. S. Carter[2] actually reaches the same conclusion so far as pyloric exclusion in an atonic stomach (the seat of benign stenosis) is concerned.

[1] J. Am. M. Ass., 1915, July 31.

[2] Am. J. M. Sc., 1917, Dec., 851.

The resection of pyloric ulcer has been advocated by many surgeons, especially by Haberer, who is unusually radical. The record of higher mortality, however, has led such able surgeons as Deaver, Berg, the Mayos, Erdmann, Peck, Finney, and others to advodate a more conservative procedure.

Unless one is absolutely convinced that it is not a benign disease, gastro-enterostomy is the preferable operation.

The method of surgical procedure in ulcer on the lesser curvature is quite varied. This is the location where excision, sleeve-resection, cauterization with or without gastro-enterostomy, gastro-enterostomy or gastro-duodenostomy alone have been advocated. Each method has its ardent adherents.

The late Rodman, who years ago advised resection because of the possibility of the ulcer becoming cancerous, had an immense following, particularly in our country and England. Balfour,[1] in his latest praiseworthy work reporting on 677 cases, arrives at the conclusion that cautery combined with gastro-enterostomy is the ideal procedure.

As internists we would err even by attempting to suggest preference for any one method. It is the skilled surgeon who, out of his wide experience, must decide what operative procedure is the best. One fact, however, is well established, that recurrence of symptoms after a gastro-enterostomy for ulcer on the lesser curvature is rather the rule than the exception.

It is essential to determine the cause of recurrence in some cases, when in others the operation is effective. In order to make clear our reasoning as to why the operative results are not uniform, it is necessary to review briefly our X-ray observation as to the mode of activity of the stomach with a florid ulcer on the lesser curvature, especially when the organ is of good tone.

In this case the stomach when filled with contrast substance is usually hypertonic, much shorter than normal. The fornix (fundus) part is much wider than the tube and sinus-pylorus portion; pylorus and cardia are nearer each other, in extreme cases forming the Schmieden tobacco-pouch stomach.

[1] Surg., Gynec. & Obst., 1917, xxiv, 731.

In addition to the hypertonicity, hyperperistalsis especially in the region of tube and sinus, is very marked. During the florid state of ulcer, in a great number of cases there is a deep persistent contraction on the greater curvature opposite the seat of the ulcer. The pyloric function in the early part of digestion—first and second hour—is normal, or allows the food to pass at times more rapidly than normal. Later, after two or three hours, the hypertonicity and hyperperistalsis in tube and sinus are diminished, while the pylorus shows considerable spasm.

What are the factors which create these phenomena? It seems to us that the following explanation is applicable: the hyperperistalsis and hypertonicity early in digestion go hand in hand with the existing hypersecretion. Chymification, therefore, is hastened and the food made ready to pass the pylorus very quickly. The pylorus opens up readily because of the acid influence on the duodenal secretions and the absence of the lesion in the pylorus proper. Later in the course of digestion the hyperactivity of the stomach subsides because the musculature tires.

During the period of the hyperactivity of the gastric musculature, food still in need of chymification is present, secretions even excessive, but the peristaltic action essential for complete chymification, in order that the food may be ready to pass the pylorus, is missing. Hyperacid and coarser particles of food bring about spasm of the pylorus. The persistent contraction opposite the ulcer, which indicates the protective feature of the ulcerated area, likewise disappears with relaxation of the muscular tone. Pylorospasm plus the exposure of the ulcerated area to the chyme and gastric secretions bring about the pain. Gastro-enterostomy in these cases furthers a more rapid evacuation of the contents. During the period of hypertonicity and hyperperistalsis chymified and well prepared food is transmitted through both the old and new opening, so that after two and a half or three hours very little food is left to bring about an excess of free acid. In addition the regurgitating intestinal juice through the new stoma and some duodenal

juice entering through the pylorus tend further to neutralize the gastric secretions, thereby preventing further irritation of the ulcer and favoring its healing.

It is self-understood that for months after the operation (and in vagotonics with tendency to hyperacidity even indefinitely) care must be exercised as to quality, quantity, and time of eating. The mental state of the patient must be so controlled as to prevent excessive acid secretions, thereby avoiding recurrence of the old ulcer or formation of a new one.

In ulcer on the lesser curvature in hypotonic and atonic stomach the gastro-enterostomy is only too often a failure. To facilitate explanation a brief discussion as to secretions and motility before operation is not superfluous.

The acid secretions are usually increased; the X-ray appearance of the stomach in the course of filling reveals a degree of almost hypertonicity; namely, active peristalsis and marked indentation on the greater curvature opposite the ulcer. This stage, however, due to the weak musculature, readily gives way and relaxation and atony set in. So transient is the stage of hypertonicity that unless the filling of the stomach is watched fluoroscopically it escapes observation.

With hypersecretion and loss of tone the predominating factors, marked six-hour residue is present, notwithstanding the fact that the pylorus is not the seat of the disease. Favorable results of a gastro-enterostomy depend on the more rapid emptying of the contents through both openings—which in itself is a factor in diminishing acid secretions; and in addition the intestinal juice further neutralizes the acidity, thereby conducing to healing of the ulcer.

Unfortunately various complications are apt to arise, not the least infrequent of which is the persistence of the ulcus symptoms: pyrosis, vomiting, pain, regurgitation of sour fluid, etc. These are the consequence of hypersecretion and spasm of both openings, and in many cases may be overcome by prolonged ulcer treatment.

It seems to us worthy of suggestion that in cases of that nature the gastro-enterostomy should, where practicable, be preceded by internal treatment directed against the hyperacidity and weakened tone of the stomach. Small gastric lavages with 5 per cent bicarbonate solution every morning for one week; alkalies by mouth according to the method of Bourget or Sippy, belladonna in the form of suppository, and milk and cream diet in quantities not exceeding 6 to 8 ounces every two hours.

A postoperative complication most common in these ulcers (as yet unaccounted for) is persistent vomiting, sometimes leading to a fatal termination. Given the clinical facts that the deeper the ulcer on the lesser curvature the more the tendency to disturbed tone and vomiting; also the observations of surgeons (A. A. Berg, personal communication) that resection of the ulcerated lesser curvature leads to uncontrollable and fatal vomiting—it seems plausible to assume that the interrupted conductivity of innervation on the lesser curvature disturbs the current of normal peristalsis and leads to retroperistalsis.

In the course of our work we read with interest the results of the experiments of W. H. Barber[1] who found that the removal of a saddle-shaped section from the lesser curvature disturbs the emptying power of the stomach. This he attributes to disturbance in the relationship of the neuromuscular structure, not to mechanical operative interference.

Surgeons of experience, in addition to excision or cauterization (Balfour) and gastro-enterostomy, perform a jejunostomy through which the patient is fed until normal activity of the stomach is re-established.

Other complications and sequelæ like gastrojejunal ulcer, and postoperative adhesions may occur here, as after a gastro-enterostomy for pyloric ulcer.

Gastrojejunal ulcer is not an infrequent sequel of a gastro-enterostomy. It was first described by H. G. Peterson[2] and later more completely by W. J. Mayo.[3]

The most complete contribution on the X-ray diagnosis of gastrojejunal ulcer was

[1] Ann. Surg., Phila., 1917, Dec., 672.
[2] Ann. Surg., Phila., 1909, p. 367.
[3] Surg., Gynec. & Obst., 1910, x, 227.

furnished by Carman and Balfour[1], Carman and Miller.[2] Peterson and W. J. Mayo found most of the gastrojejunal ulcers to be the result of a non-absorbed suture material. They found, however, that the ulcer was present even when the Murphy button was used.

Clinically the symptoms of the original ulcer may recur, and absolute diagnosis by symptoms alone is impossible.

According to Carman and Miller who studied roentgenologically 14 cases of gastrojejunal ulcers, the following roentgen-ray manifestation should be sought in order to establish a diagnosis.

1. Deformity of the stoma, which can be made visible by lifting up the overhanging lower border by manual pressure and exposing the anastomosis, if it is on the horizontal part; or examine in the oblique position if anastomosis is on the vertical part.

2. The dimpling at point of anastomosis is exaggerated and irregular. If gastrojejunal ulcer develops after an anterior gastro-enterostomy, the ulcerated area may be so thickened as to give rise to a palpable mass.

3. Narrowing and deformity of the afferent loop of the jejunum.

4. Patency of stoma not free, as evidenced by the narrow stream of the contrast substance and marked six-hour residue.

5. Exaggerated peristalsis of the stomach.

6. Lessened mobility of the stomach if adhesions are present.

7. Spasticity of the stomach, due to reflex irritation.

8. Dilatation of the duodenum.

Not all signs must be present. The most significant are the deformity and irregularity of the afferent loop, narrowing of the stoma, and the exaggerated dimpling, and sometimes the formation of a pouch at the stoma.

[1] J. Am. M. Ass., 1915, lxv, 227.

[2] Roentgenologic diagnosis of diseases of the alimentary tract, Philadelphia, 1917.

Where the patient is in a condition to stand a prolonged operation for ulcer on the lesser curvature very good results are obtained by sleeve-resection. As demonstrated by experimental work and the experience of numerous surgeons and clinicians, shortly after resection the stomach is somewhat smaller, but in the course of time full accommodation sets in.

Complications may occur after a gastro-enterostomy where the ulcer was not excised, such as a hæmorrhage or perforation; furthermore the formation of a new ulcer may be the cause of recurrence of symptoms.

Chronic appendicitis, if overlooked at the time of operation, may continue to give rise to gastric disturbances simulating ulcer. This is especially true of an appendix which is small and from external appearances looks normal, but the mucosa is atrophied. Diseased gall-bladder, not infrequently concomitant with ulcer, does give rise to postoperative gastric symptoms. Sometimes, long after gastro-enterostomy, the unhealed ulcer perforates slowly, causing local peritonitis which in turn may form a large exudate manifested by a palpable mass, or this mass may suppurate, leading to abscess (Wilensky).

Hernia in the abdominal scar, giving rise to the persistence of ulcer symptoms, has been mentioned by Moynihan.

Where anæmia is a marked factor for a prolonged period after operation and where infection can be localized, Wilensky rightfully points out that the postoperative ulcer symptoms may be overcome by treating the underlying causes.

Operative procedure for hour-glass contraction, extensive adhesions, deeply penetrating into neighboring organs, is entirely of surgical interest. The method of operation depends altogether upon the judgment of the surgeon.

THE ABDUCTION TREATMENT OF FRACTURE OF THE NECK OF THE FEMUR

A Comparative Analysis from the Standpoint of Technical Efficiency

By ROYAL WHITMAN, M.D., F.A.C.S., New York

An exposition of efficiency as suggested by the title of this paper implies a radical divergence from conventional practice. And, in order to make the contrast as complete as possible in its emphasis on the mechanics of the problem, the illustrative cases have been chosen from youthful subjects.

Case 1. Epiphyseal fracture. A boy 16 years of age was first seen on August 7, 1917. Seven weeks before this he had slipped and injured his left hip. There was some pain at the time, and apparently a slight limp had persisted until July 14, when making a sharp turn while diving, there was severe pain in the hip and he was unable to walk. The following day he was taken to a hospital and after X-ray examination, a diagnosis of fracture was made. On July 17, an attempt was made under anæsthesia to reduce the deformity and a plaster spica was applied. A second X-ray picture taken on August 1, showed that the result was unsatisfactory and he was discharged with the suggestion that he seek treatment elsewhere. On August 7, he was admitted to the Hospital for Ruptured and Crippled. At this time he was unable to stand. The left limb was extended, rotated outward and slightly adducted, all movements were restricted and painful and there was one inch of shortening. A diagnosis of epiphyseal fracture was made, which was confirmed by the X-ray picture (Fig. 1).

On the following day the deformity was reduced by the abduction method. By direct manual traction the limb was drawn down to its normal length, then rotated inward, and finally abducted to the extreme limit and fixed by a long plaster spica. The second picture, taken through the plaster spica shows the reduction of the deformity and the security of the reduction assured by direct bony contact of the two fragments and of the trochanter with the pelvis (Fig. 2). A third picture, taken in February, 1918, when functional recovery was complete, shows the anatomical cure (Fig. 3.)

This case is characteristic of the ordinary type of epiphyseal fracture, which is practically limited to adolescence. The junction is weakened by a primary injury that causes slight disability. The symptoms of limp, stiffness, and discomfort persist, and finally, in correspondence to the progressive deformity, or sudden complete fracture, increase or become disabling. In many instances the gradual displacement is accompanied by a process of repair, and as the symptoms are usually mistaken for disease, the patient may not come under observation until months or years after the original injury, so that an open operation is usually required in order that the fragments may be completely separated and replaced in normal relation, as I have described in previous papers.

Case 2. Complete fracture of the neck. A girl, 5 years of age. was admitted to the hospital on July 21, 1917. Two weeks before this she had fallen down stairs and had since been unable to use the right limb, and had suffered constant pain. The physical examination presented the ordinary symptoms of fracture of the neck of the femur of the adult type, and the character of the injury is shown in Fig 5.. She was treated by the abduction method, and the X-ray taken four months later shows the process of repair. It may be noted that the neck is somewhat shortened as is often observed in adult cases when the fracture is at this point, but that its angle has been preserved, thus assuring normal function.

Case 3. Incomplete fracture. A child, four years of age, illustrates a type of incomplete fracture in the neighborhood of the trochanter. This is the most common form of fracture in childhood and it is usually overlooked because the patient often walks within a few days or weeks after the accident. The indications for abduction as a means of closing the wedge-shaped opening and restoring the normal angle of the neck are so obvious that no further comment seems necessary.

These cases have been selected because the position of the injury corresponds fairly with the three types common in adult life: the intracapsular; complete near the base of the neck; and the incomplete, which presents a clinical resemblance to the so-called impactions.

The opportunity offered by the identification of the fracture in children, many years ago, for the observation of its immediate and remote effects, demonstrated

Fig. 1.

Fig. 2.

Fig. 3.

Fig. 1. Case 1. Epiphyseal fracture. The apparent shortening of the neck and the loss of the prominence of the trochanter are explained by the outward rotation of the limb.

Fig. 2. Case 1. Taken through the plaster spica after reduction. The neck fragment is now within the acetabulum; the trochanter is apposed to the side of the pelvis and symmetry is restored.

Fig. 3. Case 1. Six months later, showing anatomical cure. Compare with Fig. 1.

clearly that conventional treatment was utterly inadequate both in means and purpose to assure the primary essentials of success, and that distortion and shortening of the limb, limitation of motion and discomfort, the characteristic results in childhood as in adult age, were the direct consequences of inefficiency and neglect.

This positive illustration of cause and effect led to the evolution of the abduction treatment, which had the great advantage that it was first applied in a class of cases in which mechanical efficiency was the only consideration. When, therefore, this efficiency had been demonstrated and its effects confirmed by the final results it only remained to test the new method under less favorable conditions.

This test has long since proved that it has a wider range of practicability than conventional methods which are generally supposed to be better adapted to age and infirmity, and that the results are more directly determined by the quality of the treatment than in any other injury of its class.

The statement that conventional treatment is inadequate to assure the primary essentials of success, may be easily verified by technical analysis of the methods in common use, the basis of all being traction on the limb. Occasionally, it is applied in the combined form of Maxwell, or made more direct by the insertion of nails, or ice tongs, in the femur, but usually by adhesive plaster, supplemented by a side splint. The so-called extension must be light if the fracture is supposed to be impacted, sufficient to relieve pain in hopeless cases, and, if the fracture is complete, it is applied ostensibly for the purpose of reducing displacements and fixing the fragments during the period of repair.

Traction in whatever form, is inadequate, because the mechanical problem at the hip-joint is quite different from that in other situations. If the fracture is, for example, of the shaft of the femur, a sufficient pull upon the limb should reduce the overriding, while the tension on the ensheathing muscles should align the fragments and thus assure the resistance of end-to-end apposition. The neck of the femur projects at an angle and the fragments lie in a lateral relation, so that the resistance of mutual pressure which is absolutely essential to repair in fractures of the small part of the neck, cannot be assured by this means. Even if lateral apposition

Fig. 4. Case 1. The plaster spica properly applied in complete abduction, complete extension, and slight inward rotation. The elevation of the head of the bed is shown.

is attained, it can be maintained in the absence of bony resistance only by constant tension. Thus at best, and in this limited sense, traction is unreliable, since it is not under single control.

The purpose of treatment is of necessity determined by the means at command and the accepted rules of practice in adaptation to this inadequacy and unreliability are summarized in the following quotations from a leading treatise on fractures:

"The ideal object of treatment, restoration of form and function, is rarely to be attempted or even sought.

"The first indication is to save life, the second to get union, the third to correct or diminish displacements."

The abduction method is, by contrast, mechanically adequate to apply surgical principles. Consequently, the sequence of the conventional indications is reversed, because "the correction or diminution of displacements," the prerequisite of functional recovery is also the first essential of repair.

In fracture of the neck of the femur the head being fixed in the acetabulum, the displacement is always of the outer, or limb, fragment. If the separation is complete the displacement is usually upward, backward, and outward, and to appose the fragments the limb must be lifted forward, rotated inward, and drawn downward to its normal length. But, since the neck of the femur projects from the shaft at an angle, the apposition is in a lateral relation and is unstable because there is no point of resistance. If now, the limb be abducted to the normal limit, the extremity of the neck is brought down to a horizontal plane. As the capsule surrounds each fragment its tension, consequent on abduction, aligns them, and since the head is fixed by the acetabulum, forces an end-to-end and resistant contact. Furthermore, at the limit of abduction the upper border of the shaft fragment and the trochanter are apposed to the rim of the acetabulum and the side of the pelvis. Thus, security is assured by the tense capsule, by direct and indirect bony contact, and by the muscular impotence incidental to the attitude of complete abduction.

The so-called impactions, or incomplete fractures, are almost always accompanied by deformity, the neck of the femur being forced downward and backward on the shaft, so that its relation to the pelvis is such as it would be if the limb were adducted and rotated inward. In other words, the neck of the femur is in contact with the upper border of the acetabulum while the shaft is in line with the body. This contact fixes the inner fragment so that by traction, inward rotation and abduction of the shaft the normal relation may be restored.

It may be noted that the characteristic deformity of fracture of the neck of the femur of all types is loss of its upward inclination. It is upon the normal angle that the range of abduction is dependent, the restriction of which entails insecurity of support and a compensatory distortion of the pelvis that exaggerates the disability supposed to be inevitable after this injury (Fig. 10.).

Fig. 5(at left). Case 2. Complete fracture of the neck near the base.
Fig. 6. Taken after removal of the plaster spica showing the process of repair and the restoration of the normal angle of the neck assuring the range of abduction.

The traditional impaction is a firm implantation of one fragment in another, or other resistant relation that assures contact and thus repair. This is, however, merely a clinical conception, suggested either because the deformity is slight or because some voluntary control of the limb is retained, which is rarely confirmed by X-ray examination, or by the test of reduction. Deformity to a degree to embarrass function should always be corrected even if resistant, because the manner by which this is accomplished has no analogy to the "breaking up of an impaction," and because the more accurate adjustment of the fractured surfaces assured by correction, far from endangering union, is in many instances the only means of assuring it.

When this adjustment has been accomplished, a long plaster spica is applied, fixing the limb in full extension, full abduction, and slight inward rotation. Although the spica is a direct support, its chief function is to hold the limb in the selected attitude that makes the internal or anatomical splinting effective, as may be demonstrated by X-ray examination through the plaster at intervals of weeks or months.

From this comparative analysis, it should appear that the abduction method is adequate because it utilizes the construction of the joint and its mechanical environment to reduce deformity and to fix the fragments in apposition.

That routine methods are inadequate, because they are not adapted to the conditions presented by the situation and character of the injury, and, since purpose is of necessity dependent upon the means of its accomplishment, surgical principles have been modified or disregarded in accomodation to this initial deficiency.

The question at issue, therefore, is one of mechanics, and in order to present this clearly and to follow as it were the line of least resistance in the argument, youthful subjects have been chosen for demonstration. For if opportunity is essential to success in cases of the most favorable class, it must be doubly so, if for any cause the capacity for repair is lessened.

In one particular, conventional practice is thoroughly efficient, namely, in explanations for anticipated failure, of which the first is physical weakness which may prevent or modify local treatment. These illustrative cases will serve, by contrast, to call attention to an important class of fractures as yet unrecognized in the textbooks and to emphasize the fact that the neck of the femur is mechanically a weak point in the skeleton. It becomes relatively more vulner-

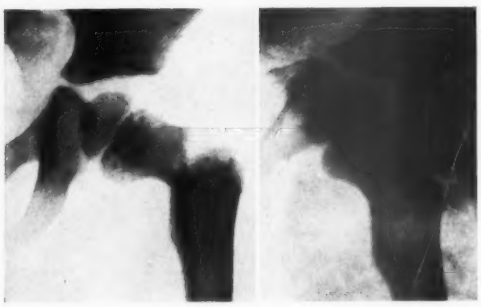

Fig. 7 (at left). Case 3. Typical incomplete fracture in childhood.

Fig. 8. Case 3. After reduction by the abduction method.

able in advanced life because of the lessened muscular protection, and thus the greater liability to missteps and falls. But, although it is the characteristic fracture of old age, it is common at any period, and in by far the larger proportion of the cases, efficient treatment may be applied without the slightest danger to the patient.

It is from this standpoint, as a routine treatment for all types of fracture of the neck of the femur that the details of the abduction method are now presented.

The patient clothed only in fitted shirting or a combination suit of underclothing, having been anæsthetized, is lifted to a pelvic rest screwed to the end of the table and provided with a perineal bar for counter pressure, the shoulders resting on a box of equal height. The limbs, extended and side by side, are each supported by an assistant. Direct manual traction on the limbs is then made by the assistants against the resistance of the perineal bar, while the surgeon, standing on the injured side, lifts the thigh upward, guiding the trochanter to its normal position.

When the shortening has been reduced as demonstrated by comparative measurements, the limb, which is usually rotated outward, is turned until the patella points slightly inward. The two assistants, still exerting equal traction on the limbs then abduct them, that on the sound side slightly in advance, in order to demonstrate the normal range and to balance its fellow, so that the tension on the capsule as the fracture is adjusted may not tilt the pelvis upward. A final inspection shows the extended limbs equally abducted on a level pelvis with all the land marks corresponding. Attention is again called to the order of the manipulation, direct manual reduction of the shortening and outward rotation preceding the abduction.

The so-called impactions are usually reduced as easily as those that are evidently complete, resistant cases being far more often encountered in early life, when the fracture may be incomplete or of the epiphyseal type. The impacted fracture has lost its former significance, because in the classical form it is rare, and because the abduction method assures reduction without violence, supplemented by immediate and secure fixation.

The typical attitude in which the limb is fixed after adjustment of the fracture is one of complete abduction, complete extension and slight inward rotation. The knee is slightly flexed and the foot slightly adducted and in a right angular relation to the leg.

In the application of the spica the body and limb are first carefully protected by bandages of sheet wadding and cotton flannel made especially thick about the upper part of the chest, the pelvis and the sacrum. The plaster support should extend from the nipples to the tips of the toes. It should be thick and unyielding about and below the joint, completely covering and enclosing the buttock.

The spica should be cut to permit the full flexion of the other thigh. If the patient complains of constriction of the chest it may be split at the top, or an opening may be made over the abdomen as in Figure 4. Another covering of shirting may be drawn over the plaster and sewed to the first thus binding the margins with soft material.

As has been stated, the purpose of the support is to assure anatomical rather than direct splinting,. The long spica is most effective because the leverage above and below the joint is fairly equal. The limb is hyperextended in order that the strong anterior wall of the capsule may be made tense and because support in this position checks any tendency to backward displace-

Fig. 9. Showing the range of normal abduction and its limitation by bony contact on one side; and the depression of the neck and limitation of the abduction consequent upon uncorrected deformity on the other.

ment of the outer fragment to which the force of gravity predisposes. Slight flexion at the knee reduces the strain on the joint, and the inward rotation follows the principle of overcorrection of the pre-existing deformity. When the plaster is firm the patient is placed in bed, the head of which has been raised a foot or more by blocks. This inclination compensates for the pillow and, in contrast with the elevation of the foot of the bed, as is usual when traction is employed, improves the blood supply of the injured part.

If the plaster spica has been properly applied and adjusted it is far more comfortable than any appliance that, like traction, requires rest upon the back. The patient may be turned at intervals to the side, or completely over, to relieve the pressure, or even moved from place to place without discomfort. Thus, hypostatic congestion and bed sores may be prevented.

Various modifications of the support are sometimes used by other surgeons. For example, the other thigh is included in the plaster. This adds to the security of the fixation if the adjustment is not accurate, but has the disadvantage of restraining the sound limb. The spica is applied in flexion at the hip and knee, with the aim of permitting the sitting posture. This may be an advantage in the treatment of the aged, but the adjustment of the fracture cannot be as accurately determined, while the flexed attitude might induce resistant contractions. Both limbs are fixed in slight flexion, and abduction by a short spica extending only from the umbilicus to the knees. The flexed attitude increases the pressure on the sacrum while the bilateral abduction makes it difficult to turn the patient to the ventral position. Rotation of the limb is not so well controlled and there is the further danger of œdema of the leg. Long spicas are also applied extending above only to the umbilicus. These are far less effective as supports and are usually less comfortable than those in which the leverage above and below the joint is more nearly equal.

Fig. 10. The caliper hip splint which permits locomotion without direct weight-bearing.

The apparatus required in applying the treatment is of the simplest description and can be easily obtained or improvised. The patients are anæsthetized to relieve discomfort and because muscular relaxation is essential to complete abduction. Gas and oxygen if skillfully administered answers the purpose and should be comparatively free from danger even in advanced life.

There are exceptional cases of fracture without deformity, and others of actual impaction, in which, although the neck is shortened, its angle is preserved so that fixation of the limb in moderate abduction without anæsthesia is all that is required. There is a third group, in which because of the condition of the patient, the treatment must be modified. It is my opinion, however, that a treatment holding out a prospect of cure, that relieves pain, that permits changes of posture, thus preventing hypostatic congestion and bed sores. is less dangerous than traction, that requires persistent rest upon the back and within rational limits, than non-treatment with its consequent discomfort, confinement and discouragement.

The plaster spica is retained as a support from eight to twelve weeks, a time sufficient, it may be assumed, to assure adhesion of the fragments, but by no means a resistant union. After its removal the patients remain in bed preferably for several weeks for massage, passive and active movements of the joints and re-establishment of muscular control. Several times a day the limb is drawn out by the attendant to the full limit of abduction, otherwise a gradual restriction of its range will be apparent, a clinical indication of the fact that flexion and adduction are the natural accommodations to weakness and discomfort. Weight-bearing, therefore, should never be permitted with the possible exception of certain fractures at the base of the neck, or in childhood, for at least six months and often only after a much longer interval, because repair is slow, and because the strain is much greater than in any other situation. The indications for resumption of functional use are the situation of the fracture, the process of repair as shown by X-ray pictures, and above all, by the restoration of voluntary control and the freedom from discomfort on passive movements. Since the period of reconstruction is so prolonged, the use of a caliper hip splint which permits locomotion without direct weight-bearing is desirable; otherwise crutches must be employed (Fig. 10).

The protection of the weakened bone and joint, which is almost as essential as the primary correction of deformity, has been entirely neglected in conventional treatment, weight-bearing being permitted and encouraged even, within a few weeks or months, with the aim of hastening repair. It is fair to assume, therefore, that the nutritive changes resembling arthritis deformans sometimes observed as later effects of the injury are, like the deformity and the restricted motion incident to it, the consequences of a treatment, which from beginning to end is consistently inadequate.

The results, in keeping with its character, are so extraordinarily bad that they have served thus far to justify the treatment

that produced them, on the theory that the outcome is determined primarily by the situation of the fracture, or by the relation of the fragments to one another, or by deficient nutrition, or by other factors over which the surgeon has no control, and that conventional practice is a clinical adaptation to exceptional conditions. Consequently, that efficiency, as it is understood in the treatment of other fractures, even if it were practicable, is undesirable since it might jeopardize the result. This is an argument in a vicious circle, from which there is no escape if one accepts the premises on which it is based. If, on the other hand, one discards inadequate treatment, one of necessity rejects all the conclusions that support it.

The practical point then is, whether efficiency and all that it implies is worth while; in other words, whether opportunity that can only be assured by adequate treatment will favor repair, or whether the result is actually determined by chance.

SUMMARY

The arguments in favor of surgical efficiency may be summarized as follows:

1. That non-union occurs in childhood under the same conditions as in adult life, although there can be no question of the capacity of the tissues for repair.

2. That repair after non-union is the rule when at open operation the fragments are freshened and adjusted, indicating that fixation in apposition is the first essential of success.

3. That experience in bone grafting proves that union is possible under far less favorable conditions, as regards the blood supply, than in fracture of the neck of the femur.

4. That the obstacles to repair, whether intrinsic or extrinsic, actual or fanciful, that have thus far justified inadequacy and neglect furnish the strongest presumptive evidence in favor of opportunity as the determining factor in the result.

5. That it has already been abundantly proved by practical experience that repair is possible in every variety of fracture at the hip and at any age, and, although it cannot be asserted that opportunity will always assure success, it is self-evident that want of opportunity assures failure. Consequently, the responsibility for opportunity, upon which the result is primarily dependent, rests upon the one who selects and applies the treatment.

This conclusion, however revolutionary as contrasted with conventional teaching, is, in effect, simply that surgical principles, whose application has been made practicable by the abduction method, should now govern the treatment of this as of other fractures.

The abduction treatment as the exponent of these principles has made steady progress in recent years. To quote from the *Nouveau Traité de Chirurgie:*

"Cette méthode préconisée par Whitman est à l'heure actuelle partout appliquée."

This encourages the belief that when the treatment is properly presented in the textbooks it will be generally adopted, because the method is efficient, the purpose definite, the effects demonstrable, and the patient under single control.

In other words, because it meets in a comprehensive sense the conditions essential to success, as contrasted with conventional practice which is lacking in each of these particulars, and which has been so thoroughly discredited by results as to furnish a legitimate excuse for the virtual neglect which has thus far been the portion of these unfortunate patients.

FRACTURES OF THE LOWER END OF THE RADIUS

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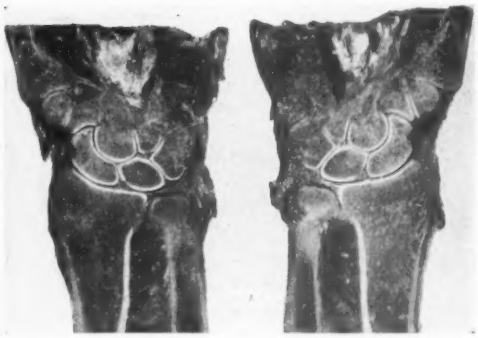
THE subject of fractures is as old as the human race and I will make no attempt to advance anything new. But it is my desire so to stimulate renewed interest in this very large and extremely important branch of surgery, and by calling your attention to the following facts to remind you that the treatment of fractured bones has not as yet become a perfected science.

The surgeon who makes it a part of his practice to treat fractures is confronted by these facts with increased frequency: that to treat fractures according to modern surgical principles necessitates the aid of a competent roentgenologist, a very thorough knowledge of human anatomy, a considerable amount of mechanical ability, a definite understanding of the pathological changes that may take place during the process of repair of the bone, expert operative technique, a wide experience and good surgical judgment.

Like the term "rheumatism," the term "Colles' fracture" covers a multitude of conditions, and as the term "rheumatism" is applied to many forms of arthritis, so also is the term "Colles' fracture" used to describe many types of fractures of the lower end of the radius, as well as at times including lesions in the lower end of the ulna.

Hamilton, in 1860, in his treatise on "Fractures and Dislocations" used the term "so-called Colles' fractures," intimating that then, as well as now, the term conveyed an indefinite idea, and his use of the phrase, "the peculiar character of the displacement which characterizes the Colles' fracture," would indicate that the fractures without displacement or those with a different type of displacement were not then classed as Colles' fractures; while today the term is so loosely applied that most fractures about the lower forearm region are spoken of as Colles'. That a Colles' fracture is a rather definite lesion and due to quite a definite mechanical force is well understood, but this fact is too often lost sight of in the descriptions of the various fractures involving the lower end of the radius. Observation has taught us that there are many injuries in this region that are not of Colles' type and cannot be treated as such. While there are a great many discrepancies in the descriptions of this type of fracture which Colles described, about one hundred years ago, yet the concensus of opinion gives Colles the credit for having described the most common type of these fractures. It is characterized by the so-called "dinner fork" deformity, with the line of fractures within three-fourths of an inch of the lower articular surface of the radius, and extending obliquely downward and forward, thus permitting the lower fragment to be displaced upward and backward. This causes the articular surface of the radius to look slightly dorsalward and more toward the thumb, and the styloid process of the radius to be raised to the level of the ulnar styloid or even a little higher and giving the hand a position of slight radial adduction, thereby producing a distinct prominence of the lower end of the ulna. It seems quite evident that many of the less severe fractures of the lower end of the radius were not recognized as fractures and thus not considered by Colles, and perhaps this was better for the patients, for as I will endeavor to show later, some of these fractures offer a better prognosis by no treatment at all than would be the case if they were recognized by the X-ray and, as so often happens, were overtreated. However, many of these serious lesions are not X-rayed and are thus too often mistaken for minor injuries and are not properly treated. The late John B. Murphy stated at the meeting of the American Medical Association, in 1912, that 85 to 92 per cent of Colles' fractures resulted badly as they were then treated. This percentage, it would seem, is a little high, and, it is quite likely that Murphy's statement was based



Figs. 1 and 2. Longitudinal sections of the wrist-joint showing the relations of the carpal bones to the radius and ulna. Note that the force of violence may be transmitted to the ulna as well as to the radius, and how readily callus may be deposited about the various articular surfaces, following fractures.

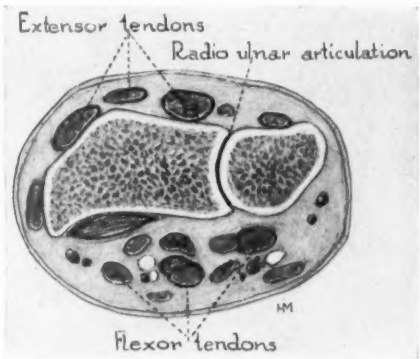


Fig. 3. (1) Note the extent of the radio-ulnar articulation, which is frequently involved in the fracture and will be filled with callus if precautions are not taken to prevent it; (2) note the close proximity of the extensor tendons on the dorsal and internal-lateral surfaces, which will be included in the adhesions about the fracture when it is immobilized for too long a time, and (3) note further the numerous flexor tendons that may be included in the inflammatory reaction of the more severe cases and lead to adhesions if flexion and extension of the fingers are not insisted upon after the first two or three days.

upon his personal experience with referred cases, which to a large extent were probably those that had been carelessly treated by the general practitioner, before they found their way into his clinic.

Every surgeon who has treated this type of injury often, or has seen a large number of cases, will doubtless recall some that have resulted badly, and others that should have yielded better results, and can recall cases treated by other men in which the results were far from ideal. Who of us will not agree that we should turn our attention for a time to the treatment of these common and serious lesions and thereby establish some better methods, or institute a campaign of education that will enable the average physician and general practitioner to better use our present methods?

ETIOLOGY

The fractures involving the lower inch of the radius are largely limited to middle and advanced life and a very large percentage occur after middle life.

Very few fractures in this region are found in individuals under twenty, and when such an injury does occur it is prone to involve the epiphyseal line. It is the youngest that falls most frequently upon the outstretched hand, and yet suffers so rarely from any bone lesion, and when the violence is sufficiently severe to produce a bone lesion it may involve the epiphyseal line, but more commonly the lower third of the radius with or without the ulna, or, rarely, results in some type of fracture about the elbow. (Figures 6 to 21 illustrate the types of fractures that may occur in early childhood as a result of a fall on the outstretched hand.) The type of violence that produces the more common fractures of the lower end of the radius is too well known to deserve comment at this time; but, why apparently similar types of violence produce such widely different varieties of fractures—see illustrations—is a question that invites considerable thought, and is a phase that should not be considered lightly when treatment is being carried out.

ANATOMY

A study of the anatomy of the wrist joint (Figs. 1 to 5) will show how easily the violence is transmitted to the lower end of the radius when the patient falls on his hand; it will further show that the violence is transmitted to the ulna by two avenues of contact: namely, through the radio-ulnar articulation and through the fibro-articular cartilage between the ulna and the semiulnar. It is

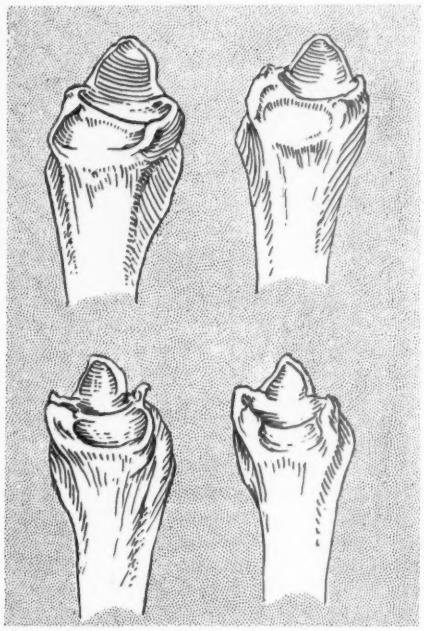


Fig. 4. Ulnar side of two right and two left radii. Note the extent and variation in the articular surfaces and the dorsal and ventral bony prominences. The line of fracture frequently enters these articular surfaces and they must be protected against the deposit of callus.

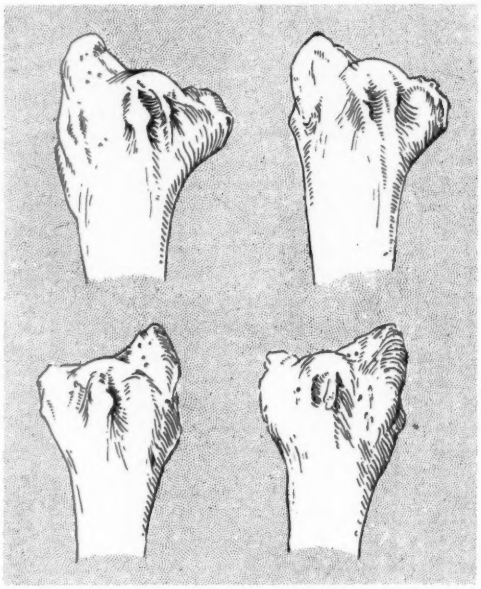


Fig. 5. Dorsal view of two right and two left radii. Note the marked variations in the styloid processes and other bony prominences. It is these variations that must be considered carefully when interpreting clinical and X-ray findings.

logical to suppose that the radius fractures primarily in these injuries and then, if the force of the violence is sufficient, the ulna will yield. A study of the sections will show that there exists a difference in the arrangement of the bones of the wrist and their relation to the radius and ulna which doubtlessly accounts in a measure for the variations in the line of fractures.

A study of the cross sections of the forearm at the level of the radio-ulnar articulation will show how intimate is the association of various tendons and how they are brought into immediate contact with the fractured radius at this level, on both ventral and dorsal surfaces. This fact should be uppermost in the mind of the operator who is treating one of these fractures.

PATHOLOGY

In the discussion of fractures, the term pathology seemingly conveys only the picture of the various changes that take place in the bone, as a result of the injury and during the process of repair, while the ultimate outcome of a great many fractures depends far more on the pathological changes that occur in the soft parts, not so much those that occur at the time of injury, but those that are prone to occur during the repair of bone.

That every fracture of bone is complicated by injury of the surrounding soft parts is a fact that needs no comment, but in some fractures considerable changes are thus produced, also inflammation the severity of which is in direct proportion to the extent of the primary injury to the soft parts, or as may be aggravated by the treatment used.

When a fracture occurs at the lower end of the radius or in any of the bones which make up the wrist-joint, there is rarely any extensive primary injury to the surrounding soft parts; yet the structures are so numerous and lie in such close proximity to the injured bone that soon after the bone lesion occurs

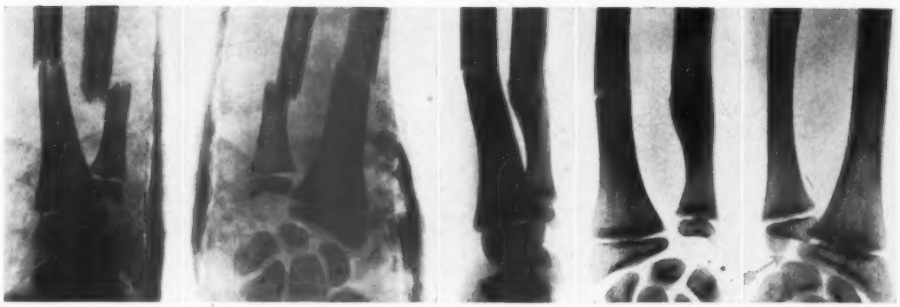


Fig. 6. Fig. 7. Fig. 8. Fig. 9. Fig. 10.

Figs. 6 and 7. T. P., age 9, on September 10, 1914, fell on the outstretched hand. Signs of fracture were very evident. After reduction, a circular cast was applied and after four weeks union seemed firm. Note that the radius fracture was incomplete and there was no displacement. Note too that ulna was allowed to unite without reduction.

Figs. 8 and 9. Same case as 6 and 7, returned to us December 23, 1914, less than three and a half months after the first injury, with a similar history and injury. Note the radius fractured at the same level while the ulna remained united. Note the ulna united firmly with the fragments displaced.

Fig. 10. Same case as 6, 7, 8, 9, now aged 12, returned to us on October 30, 1917, for other troubles. Note the complete restoration of the ulna with its medullary canal with no evidence of the old fractures. Note, however, the same shortening of the ulna in Figures 7, 9, and 10, which is not manifest clinically nor does it disturb the function of the arm in any way.

extravasation of blood and infiltration of leucocytes involve, to a greater or less extent, the delicate membranes lining the numerous tendon sheaths and synovial cavities which become roughened and lose temporarily that smoothness, which permits the free transmission of tendons and articular surfaces. As the inflammation progresses, more or less effusion takes place into the structures and, during the process of repair, if conditions are not favorable, how easily adhesions may form between the tendons and their sheaths, or connective tissue infiltration take place about the various joints, which may also involve the tendons, and which will interfere very markedly with the free movements of the many structures that are so essential to the normal function of this important joint. It is just these pathological changes that are responsible for a large percentage of the poor functional results in these fractures. When such changes have taken place we have pathological conditions far more difficult to treat than the original fracture.

The line of fracture in the lower end of the radius ranges very widely as will be seen by a study of the illustrations. When it is recalled that a large percentage of these fractures occur within an inch of the lower articular surface of the radius, it will be seen that a great many times the line of fracture will enter the radio-ulnar articulation. A few will enter the wrist-joint and in either case callus may be deposited over and about these surfaces if precaution is not taken to prevent it. Displacements of the fragments vary as widely as does the line of fracture. In no small proportion of these cases there is no appreciable displacement, even though the line of fracture may be complete and extend in almost any direction. On the other hand, the displacement may be so marked as to produce a very distinct change in the position of the hand and wrist as well as the lower articular surface of the radius, which in the large percentage of cases is made to look backward and downward. Two fragments is the rule, but there may be three or many and the smaller fragments be displaced in any direction. It is these latter cases that are apt to be followed by pathological changes in the soft tissues.

VARIETIES

I have made no attempt to classify these fractures. Roberts and Kelly have given a very comprehensive and yet confusing classi-

Fig. 11. Fig. 12. Fig. 13. Fig. 14. Fig. 15. Fig. 16.

Figs. 11 and 12. D. B., age 11. Usual history and signs of fracture present. A circular cast was applied for four weeks; function good in five weeks.

Figs. 13 and 14. H. E., age 9. Usual history and sign of fracture, radius alone fractured. A short period of immobilization was sufficient to restore a normal condition.

Fig. 15 and 16. S. A., age 7. Usual history and signs of incomplete fracture. After three weeks the patient was permitted to carry the arm in a sling without splints. The mother allowed child to go out on roller skates and the following day he returned with arm bent again. A longer period of immobilization gave a perfect functional result.

fication in which they describe fourteen varieties with fifteen subvarieties or twenty-nine different types of fractures of the lower end of the radius.

DIAGNOSIS

In Figures 1 to 5, note that there is a variation in the position of the lower articular surface of the radius; that the radio-ulnar articular surfaces are much larger in some cases than others and may be easily involved in these fractures; that trauma of the carpal bones may be readily transmitted to the ulna by means of the fibro-articular cartilage that intervenes; that there is not a fixed ratio between the level of the two styloid processes.

A study of hundreds of wrist-joints in the dissecting rooms shows a very wide difference in the articular surfaces of the lower end of the radius and ulna. In a few cases the ulna has little or no connection with the wrist-joint, while in most specimens it has a distinct articular surface. The bony prominences of the ventral and dorsal surfaces of the lower end of the radius show a very wide variation which must be remembered during the interpretation of X-ray plates and also in determining clinically the amount of deformity.

The direct diagnosis of fractures about the wrist-joint resolves itself into the diagnosis of fractures without any or all classical signs of fracture in a great many cases. For in a certain percentage of these cases the objective signs of fracture are absent, there being no deformity, false point of motion or crepitus, and the signs of local trauma may be less marked than are often present following a severe sprain, while in the absence of such findings the X-ray plate will often show a fracture. The extent of the swelling, extravasation and ecchymosis is largely dependent upon the amount of injury to the soft tissues and not the bone. The subjective symptoms of fracture, as history of injury, pain, and loss of function, are always present in these injuries. The signs of an ordinary fracture and those of the Colles type are too well known to warrant a repetition now, but, there is one sign present here which is almost pathognomonic of fracture in any superficial bone, and that is, an area of extreme tenderness along the line of fracture. This point has been called attention to by Speed and others, and is a very dependable sign in fractures of the ribs; those about the elbow as well as in those under consideration; and, when all other signs of fracture are absent, a very definite diagnosis can be made in the early hours by finding this point of extreme tenderness. It is so characteristic and so definite that the location and line of fracture can be outlined before the roentgenogram is seen. In all these fractures the roentgenologist should be consulted before treatment is instituted and in some cases during the progress of the condition. Miller's assertion that "in no place in the body are serious injuries mistaken for minor ones so fre-

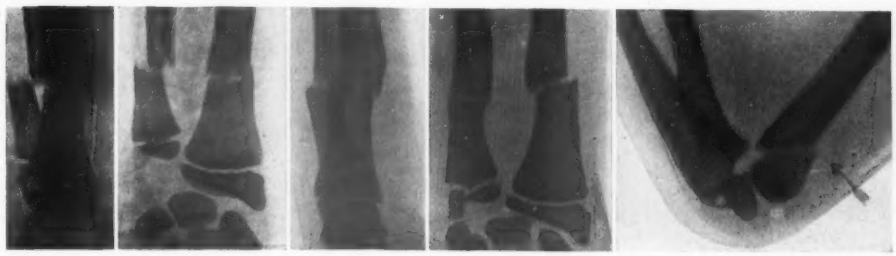


Fig. 17. Fig. 18. Fig. 19. Fig. 20. Fig. 21.

Figs. 17 and 18. R. C., age 13, on September 1, 1917, while playing ball, stepped on a potato and fell on both hands. The usual signs of fracture were present together with two small punctured wounds on the ventral surface at the level of the lower end of the upper fragments, where the bones had penetrated the flesh. Careful antiseptic treatment resulted in union without infection and return to normal function in five weeks.

Figs. 19 and 20. However, the patient returned on February 24, 1918, having fallen while roller skating and again showed the signs of fracture with marked deformity, which was reduced under anæsthesia. The line of fracture in both bones is shown to be very near the site of the original injury.

Fig. 21. V. G., aged 7, gave a history very similar to that in cases shown in Figs. 6 to 20. The patient fell while hurrying home to dinner. The symptoms indicated backward dislocation of the elbow. The dislocation was reduced under anæsthesia, but the X-ray showed a transverse supracondyloid fracture which gave evidence of never having been displaced. This illustrated the two rarer types of injury that may occur in a child, by a fall on the outstretched hand. The arm was dressed in extreme flexion, and early and frequent massage and passive movements, together with removal of the dressing in three weeks, resulted in a straight arm with almost complete flexion and extension in two months.

quently as are injuries about the wrist," would not be true if all wrist injuries were X-rayed.

Arbitrary statements and hurried conclusions about the presence or absence of bone injuries, especially near joints, are inexcusable when the services of a roentgenologist can be secured.

DIFFERENTIAL DIAGNOSIS

To differentiate the various bone lesions about the wrist-joint is quite essential from a therapeutic standpoint, as displacements must be corrected and articular surfaces protected. In all cases of injury about the wrist-joint the court of last resort, the X-ray, should be universally employed. However, if

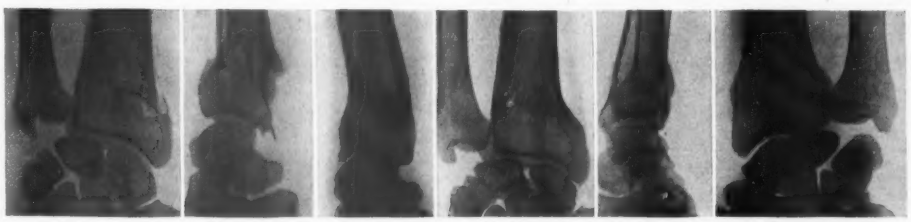


Fig. 22. Fig. 23. Fig. 24. Fig. 25. Fig. 26. Fig. 27.

Figs. 22 and 23. Mrs. F. G., age 48, gave the usual history of a fall on the outstretched hand. Signs of fracture and typical "dinner fork" deformity were present. A circular cast was applied with the hand slightly flexed for ten days, then in mid-position. Note that the line of fracture enters radio-ulnar articulation. Immobilization was discontinued at the end of three and a half weeks. Passive movements and massage were used early and frequently and the patient returned to her work as a coat maker at the end of six weeks.

Figs. 24 and 25. Same case 22 and 23; two and one half years later. The wrist is clinically and from X-ray findings practically a normal one. Both views here will show what result can be obtained under favorable conditions.

Figs. 26 and 27. Mrs. R. S., aged 38, gave usual history but usual signs of fracture were absent; line of tenderness marked; signs of trauma slight. No reduction necessary or attempted. Circular cast removed in three weeks. Frequent massage and passive movements administered and function restored with only slight deformity remaining.

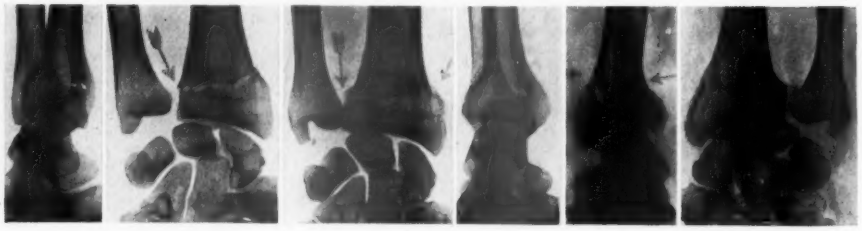


Fig. 28. Fig. 29. Fig. 30. Fig. 31. Fig. 32. Fig. 33.

Figs. 28 and 29. Miss D. M., age 20. Usual history and typical signs of "dinner fork" deformity were present. The signs of trauma were marked. Reduction was accomplished by ulnar adduction and flexion. Note line of fracture enters the radio-ulnar articulation. A circular cast was applied and a moderate amount of massage and passive movements administered and the patient returned to her factory work at end of five weeks.

Figs. 30 and 31. Mrs. A., age 50, very stout, gave the usual history, but the signs of fracture were absent. The line of tenderness was well marked. The signs of trauma were moderate. No reduction was necessary. Note that the line of fracture runs close to the radio-ulnar articulation. A circular cast was applied and very frequent and vigorous passive movements and massage were administered with result that function was completely restored.

Figs. 32 and 33. Mrs. R., age 74, fell with wrist flexed. The usual signs of fracture were absent. The line of tenderness was marked and signs of trauma slight. No reduction was necessary. A circular cast was applied for three weeks, and frequent massage and passive movements were administered. Function was well restored in six weeks.

the surgeon be true to himself and to his patient, he will not become dependent upon the X-ray, but he will make sure of his clinical findings first, draw his conclusions as to treatment, and resort to the X-ray to confirm his findings or to prove positively the absence or presence of a bone injury in the more obscure cases, and to trace definitely the line of fracture, a knowledge of which is essential to proper treatment.

Many cases of severe sprain after twenty-four to forty-eight hours may simulate a fracture very closely, but to conclude that it is a fracture without positive proof is shirking the responsibility and doing the patient an injustice. Not wishing here to belittle the importance of a sprain, I feel it my duty to state that a sprained joint should be protected, not necessarily immobilized, much longer than a joint about which a fracture has occurred.

TREATMENT

When we consider the wonderful advance in abdominal and other branches of surgery in the past quarter of a century we feel elated and are bold to acclaim what has been accomplished; but when we are confronted with the facts, that such fractures as are under consideration, were as carefully described, and seemingly as well treated or even better back in the days of Sir Astley Cooper when he wrote his *Treatise on Fractures* in 1844, as they are today, and with the statement of the late J. B. Murphy made in 1912, that 85 to 92 per cent of Colles' fractures as treated today result badly, are we going to shift the blame, or are we going to stand like men and "admit the goods"? The field of operative surgery has so engrossed the attention and enthusiasm of the surgeons of today that the subject of fractures has been woefully neglected, both in practice and in teaching. The average student of today when ready to leave college knows much better the details of an operation for appendicitis or hernia, or even hysterectomy, than he does the details of the treatment of the most common fractures, yet he is no sooner comfortably located in his new office than he is called upon to treat a Colles' or a Pott's or a fracture of even more serious nature and he applies as best he can what he has learned, to the everlasting detriment of his patient, and, at times, a dissatisfaction that may end in a suit for malpractice. Is the young physician or surgeon entirely at fault? No. The principal responsibility falls back upon those whose duty it is to teach the subject of fractures more thoroughly. As Phemister has intimated, if the term Colles' fracture were dropped from the descrip-

Fig. 34. Fig. 35. Fig. 36. Fig. 37. Fig. 38. Fig. 39.

Figs. 34 and 35. C. S., age 47, injured by back fire of auto truck. The usual signs of fracture were absent, there was no deformity, but the signs of trauma were quite well marked. Note that the line of fracture reaches radio-ulnar articulation. No reduction was necessary. A firm circular cast extending from the bend of the fingers to the middle of the forearm was applied and the patient returned to work driving his truck after the fourth day, using his left hand for cranking and steering his machine. Vigorous massage and passive movements were given every four or five days and the cast removed at the end of four weeks.

Figs. 36 and 37. Mrs. E. D., age 60, gave the usual history. The deformity was very marked. The signs of trauma were also marked. Note the peculiar line of fracture and displacement with articular surfaces of radius looking backward. The patient was intoxicated and a fair reduction was accomplished without anæsthesia. A circular cast, applied with hand flexed, was worn for three weeks. The usual massage and passive movements were administered. Functional result good.

Figs. 38 and 39. Mrs. K. T., age 42, gave the usual history. The deformity was moderate and typical; signs of fracture obscure. Note irregularity in line of fracture, and that radius shows but slight shortening. An unsatisfactory attempt at reduction was made. A circular cast with hand slightly flexed was applied. Immobilization was discontinued at the end of 20 days. The patient returned to work as housekeeper after four weeks. After one year the patient returned. An unaccountable shortening of the radius is manifest with relaxation of the radio-ulnar ligaments and quite free anteroposterior movements of the ulna.

tions of fractures about the lower end of the radius, and the more common types described according to the pathology produced, and thus present a firm basis upon which logical measures for treatment could be founded, the results obtained in the treatment of such lesions would be nearer the ideal. To classify all fractures about the lower end of the radius under one heading and call them Colles' and treat them as such, is absurd. To treat a transverse, impacted, slightly displaced fracture in this locality as the so-called Colles' is also absurd and ridiculous. That the treatment should vary according to the line of fracture, if impacted or unimpacted, the displacement, the amount of injury to the soft parts and thus swelling, and the age of the patient is logical, and only when such principles are followed will the results approach the ideal.

REDUCTION OF THE FRACTURE

The details of the various methods of reducing Colles' fractures are too well known or easily found in the various texts to justify repetition at this time. However, to assume that a reduction is to be accomplished in all, or in most fractures, of the lower end of the radius is wrong, and a study of the various types of lesions will soon convince one that in a great many of these fractures the fragments are in as near normal position as could be desired. However, in some of these fractures, a good reduction or a perfect reduction is essential to secure a good functional result.

McCurdy states that "Colles' fractures when not properly reduced at the time of the accident result in more bad deformities than all other fractures combined." It is a well known fact that fractures of the shaft of long bones with great deformity will unite and give good functional results (see Figs. 6 to 10), but not so with fractures about the joints and especially about the wrist. Brothers states that "a perfect functional result is not enough but that a perfect anatomical result is also expected." True it is, it would seem, that a perfect functional result is scarcely compatible with anything less than a perfect anatomical result. Hertzberg and others lay great stress on the importance of good reduction in these fractures, yet at times I have found that a good functional result may be obtained in some cases where reduction is far from perfect.

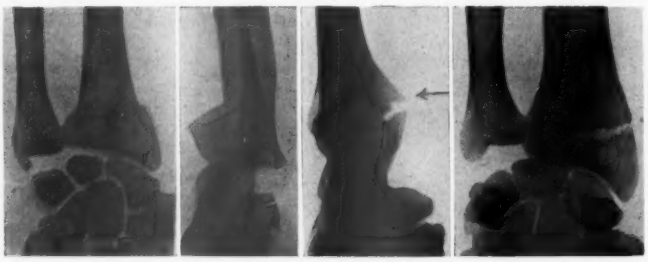


Fig. 40. Fig. 41. Fig. 42. Fig. 43.

Figs. 40 and 41. Mrs. E. R., age 52, gave usual history. Accident happened seven days ago. The deformity is quite typical but the swelling obscures the bony findings. Note the comminuted fracture and unusual displacement. The patient refused an anæsthetic and but little could be accomplished in the way of reduction. A circular cast applied in mid-position was worn for ten days; massage and passive movements. Results, good motion and function but deformity persisted.

Figs. 42 and 43. S. R., age 36, fell from step ladder. There was no deformity; the signs of fracture were absent and the signs of trauma slight, but the line of tenderness was very evident. Note line of fracture enters radio-ulnar articulation near the wrist-joint. Note also marked natural prominence on ventral surface of radius. No reduction necessary. Usual treatment was administered and the patient returned to work as a painter at the end of three weeks.

IMMOBILIZATION

That proper immobilization in some of these fractures is essential, that some need very little if any, and that others may be immobilized for too long a period, are facts that must be considered carefully when one of these cases presents itself for treatment.

Lucas-Champonierre in his earlier years was a strong advocate of the mobilization method of treatment of fractures and while in his later years his views changed some, yet he was a firm believer in the use of the simplest immobilizing apparatus and in most cases the immobilization should be continued only for a short period of time. A great many of the later writers as Mennell, Cotton, Preston, Speed, and others, are in favor of a short period of immobilization.

To treat any fracture without some immobilizing apparatus is contrary to the principles which we see manifest in nature, and that are universally employed during the repair of wounds in any tissue; yet, I believe many fractures are too well immobilized and for too long a period.

Fractures of the lower end of the radius may be immobilized by any material that will suffice to maintain the wrist-joint in a rigid position, but the padded splints or the plaster casts are unquestionably the most serviceable, and it is my opinion that plaster of Paris when properly applied is the splint par excellence for all of these injuries and should extend from the bend of the fingers to the middle of the forearm in mild cases, or to near the elbow in the more severe cases. In those fractures that are transverse or that are not complicated with displacement, the hand should be maintained in the normal relation to the forearm, in midpositions, while in those of the so-called Colles' type with an original displacement and the articular surface of the radius looking downward and backward, the hand should be maintained in the semi-flexed position, and if displacement is prone to recur, in the pistol position. Immobilization of the elbow in these cases should be discouraged. Rotation should be carried out during treatment, otherwise callus may be deposited about the radio-ulnar articulation and thus interfere with supination and pronation.

The plaster cast should be applied like a circular cast over a moderate padding of sheet wadding and before the plaster hardens a strip from one-half to an inch wide should be cut out along the dorsum to provide for swelling that might take place, and to enable the operator to remove the cast frequently for massage and passive movements and then re-apply it readily. This replaced splint or cast can be made as rigid and close-fitting

as is desired by means of adhesive plaster and a roller bandage. The cast should never extend below the metacarpophalangeal articulations, and the patient should be encouraged to flex and extend the fingers frequently after the first two or three days.

AFTER-TREATMENT

After-treatment, which includes everything from the time reduction is accomplished and the first splint is applied, is more important in securing a good functional result than is the first aid or the reduction and application of the first splints.

That a great many patients with poor functional results from these injuries are the victims of bad surgery is well recognized and that they are suffering not from the results of the original injury but from the treatment which they received in the hands of a careless operator. To prove this statement I need only cite one case of a man aged 46 who suffered from a fracture near the lower end of the radius from a back fire of his automobile. Three months later he presents himself with a useless forearm and hand, but with little or no deformity and perfect union of the fracture. He states that his doctor immobilized his arm absolutely for seven weeks.

To those of us who see these injuries frequently that statement seems almost incredible, but under no other conditions could a man get so useless a hand and arm, when associated with this type of injury. Ashhurst, in 1915, cited several cases of poor functional results, and then relates that by various operations on the "soft parts" function was restored. Miller, in 1914, stated "that the patient should be warned during the dressing period that a certain amount of fixation and swelling will be present and often persistent when the dressings are removed." Wilensky, in 1913, cited two cases that came under his observation which had been immobilized seven and eight weeks and were thus almost rigid and useless. My experience would tend to show that all such results can be avoided if proper early *massage and passive movements* are instituted, and the immobilizing apparatus be removed at the proper time. Lucas Champonierre was one of the earliest advocates of this line of treatment and was backed very forcibly by Mennell who gives a very comprehensive discussion of what is included in this method of treatment, to which all men treating fractures would do well to refer. Lucas Champonierre claimed that *mild exercise* is essentially useful for repair, but that a violent one is detrimental. Mennell states "that in cases of fractures that involve joint surfaces the only hope of effecting a satisfactory reduction is to impart suitable movements to the joint."

We also find such men as Smith, Wilensky, Neuhoff and Wolf, Hoag, Fiedler, Preston, Cotton, and Speed are strong in favor of early massage and passive movements. That the massage and early movements should be intelligently applied is an important feature, and according to most advocates should be instituted between the second and seventh day. It should be repeated daily or every other day to the end of two or three weeks when the *splints should be removed entirely* and active motions with massage be carried out until full function is restored.

The manipulations should be gentle and yet thorough, should cause little or no pain and after the first or second day the passive movements should not be extensive lest they produce movements of the articular fragments and lead to excessive callus formation.

Delayed union or non-union in these fractures is not to be expected as it practically never occurs, and in from three to six weeks, depending upon the severity of the injury, the arm and hand should be functionally restored.

OPERATIVE TREATMENT

It seems doubtful if operative interference is ever indicated in these cases if the treatment of the case even approaches the rational. Exceptional cases may be benefited, but the question of function should take precedence over deformity in deciding on operation. Considerable return of function is compatible with distinct deformity.

CONCLUSIONS

My experience in the treatment of fractures and the study necessary in the preparation of this article enables me to conclude:

1. That the teaching of the subject of fractures is woefully neglected in the present-day medical schools.

2. That every fracture in this region, as well as in others, is a law unto itself and each case must be treated according to its merits.

3. That arbitrary rules and methods cannot be followed in the treatment of fractures any better than in operative surgery.

4. That the subject of operative surgery, especially abdominal and head surgery, has so engulfed the surgical teachers of the day that they have almost entirely overlooked fractures.

5. That the average physician considers the treatment of fractures lightly and thus neglects many of the essential details.

6. That patients today have a right to demand as efficient services in the treatment of their fractured bones as they receive for their appendix or gall-bladder.

7. That a competent roentgenologist is a valuable adjunct in the treatment of fractures but is not essential to obtain good functional results in a large percentage of the cases.

8. That the surgeon who treats fractures should appreciate the importance of the many details that are essential to perfect restoration of function.

9. That we are apt to err in immobilizing these fractures too well and too long rather than in the lack of immobilization and for too short a time.

10. That careful after-treatment is the essential thing in securing good functional results.

11. That early passive movements and massage are absolutely necessary to secure perfect and early return of function.

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A CLINICAL STUDY OF PUERPERAL ANÆMIA

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OCCASIONALLY during the puerperium there is seen a form of anæmia which has not received adequate attention. Osler, in his excellent treatise on the *Principles and Practice of Medicine* (1) devotes about five lines to it, under the discussion of the etiology of pernicious anæmia. It receives only brief mention from Cabot, in Osler's system (2), and I am not aware that much notice has been given to it in any work. The disease is generally known as the pernicious anæmia of pregnancy, and it is treated under that heading by most authors.

My conception of the condition, up to the time I had seen the cases about to be reported, was that it was a severe anæmia, occurring

during the puerperium, and resembling pernicious anæmia, the blood pictures of the two being identical; that it differed from pernicious anæmia, in that recovery was the rule rather than the exception, and not infrequently the patients exhibited a leucocytosis, which is not seen in cases of uncomplicated pernicious anæmia. Such brief description is in accord with the usual text books which mention the subject.

My interest in the disease was awakened soon after I had seen the second patient.

The patient, Mrs. W., age 38, was seen in consultation with Reuben Peterson of Ann Arbor, who referred her because of a fever and an anæmia, for which he and her family physician could not account. The patient on inspection differed in no particular from those cases of severe pernicious anæmia with which we are all familiar. The panniculus was abundant, the skin lemon yellow in color and extremely anæmic. The mucous membranes were very pale. There was no general glandular enlargement. A pronounced hyperresonance of the percussion note over the chest was noted, and I am tempted to transcribe from my notes a description of the murmurs heard in the cardiac region of this patient.

There was a diffuse impulse in the third, fourth and fifth interspaces, the apex giving an ill-defined push one and one-half inches outside the normal situation. The right border was percussed one and one-half inches to the right of the midsternum. There was no shock or thrill. At, but especially to the left of, the apex was a loud blowing systolic murmur, heard very distinctly during inspiration, less so during expiration, but not absolutely disappearing. It could be followed round the left chest, and was fairly distinct between the scapula and the spine at the usual spot where it was audible at all periods of the respiratory cycle. On further examination, however, the murmur was heard all over the precordia, and very distinctly in the pulmonic area. But besides this, there was another and quite marked separate soft blowing murmur, diastolic in time, having its maximum intensity in the left third interspace, at the margin of the sternum; it was conducted upward and inward to the second right interspace, where it was almost inaudible, and it could not be heard in the vessels of the neck. The heart rate was rapid (112), the mitral first sound indistinct and the second pulmonic slightly accentuated. The pulse was collapsing, but not of a typical Corrigan type, also there was a capillary pulse seen under the nails and in the lips on gentle pressure. Duroziez's sign could be demonstrated in the femorals. There was no pistol shot and no great discrepancy between the systolic and diastolic blood pressures (110-60).

From past experience, I was persuaded to assume that the patient probably suffered from a malignant endocarditis. There was no petechial rash seen, and the spleen could not be palpated. Except for a faint trace of albumin and an occasional cast, the urine was negative. An examination of the blood revealed 1,280,000 red cells, 2,800 white cells, and a hæmoglobin of 24 per cent.

The patient was the mother of four healthy children. Two weeks previously she had passed through a normal labor, there being little blood lost at the confinement, and none before or following it. There had been a continuous irregular fever for ten days, ranging from 100 to 103.8°; the pulse rate 108 to 128; and respirations 22. Dr. Peterson insisted there was no evidence of an infection of the adnexa.

Mrs. W. was transfused directly from her husband soon after the examination, and on the following morning the signs of aortic insufficiency had disappeared. The systolic murmur persisted. The red cells were 2,120,000, whites 1,250 and hæmoglobin 30 per cent. She was again transfused a few days later, with much better results. Following this she made a slow recovery. The patient was first seen in May, 1915, and in August, 1916, she was well. The heart was not enlarged, there were no murmurs.

Shortly following these observations, I was called by Dr. Peterson to see a young women, Mrs. S., 30 years of age, who but a few days previously had been delivered of her second baby.

There was nothing in her family or past history of importance. Her confinement had been normal and there had been no loss of blood before, during or after accouchement. She had had a moderately severe bronchitis at the seventh month, which had subsided in ten days. There had been an irregular temperature, running as high as 101° at that time. The temperature after confinement ranged from 100 to 102°. When I saw her, she looked almost exsanguine. The physical examination was practically negative, except for an extreme hyperresonance of the lungs, some slight cardiac dilatation, a systolic murmur at the apex, well transmitted, and an accentuated second pulmonic sound. The liver and spleen were not palpable, and the urine was negative for bile, albumin, etc. The temperature was 101°, pulse 120 and respirations 40. The patient was about as pale as the pillow she lay upon; there was no pigmentation of the skin. The red blood-cells numbered 800,000, white cells 2,400, hæmoglobin 10 per cent (Dare).

Mrs. S. was transfused from her husband directly from the radial artery. Within 18 hours following the transfusion the red blood count was 3,600,000, white blood-cells 3,000, and hæmoglobin 58 per cent. The patient was again examined in August, 1916. Her heart was normal. There were no murmurs. She had 4,400,000 red cells, 6,800 whites, and hæmoglobin of 83 per cent.

At the time these patients were seen, there was a young woman, Mrs. C., age 22, in the medical service at the University Hospital, Ann Arbor, who complained of asthenia, paleness, and a sore mouth. Her mother had died at the age of 28 following childbirth from "pernicious anæmia."

She resembled the first patient in this report, in that she had a heavy panniculus, was very pale and of a lemon-yellow color. Ten weeks previous to her appearance at the hospital she had been delivered of her second child. The confinement had been normal, and without excessive hæmorrhage. From the fifth day after her confinement there had been a continuous irregular fever reaching as high as 102.2° which after two weeks became intermittent. Upon examination there was no evidence of cardiac dilatation, but there was a loud blowing systolic murmur over the precordium, heard best in the pulmonic area, but no accentuation of the second sounds; there was hyperresonance of the lungs, the spleen was palpable two fingers' breadth below the costal margin; the liver could not be palpated. The red blood-cells on entrance were 1,800,000, whites 4,900 and hæmoglobin of 23 per cent (Miescher). In four days the red cells dropped to 930,000, the hæmoglobin to 17 per cent and the white cells to 4,500. When she was transfused two days later, the hæmoglobin had dropped to 15 per cent. Following the transfusion the blood count was: reds 2,390,000; whites, 8,500; and hæmoglobin 34 per cent. Nine days later the blood count had again receded to 870,000 reds; 6,200 whites; hæmoglobin 18 per cent. She was again transfused and following this she made a slow recovery on arsenic and Blaud's pills. In May 1916, this patient was in excellent health; there were no murmurs over the heart and that organ was not enlarged, as determined by physical examination. The blood was apparently normal.

Recently, Mrs. A. G. entered the Medical Service at Harper Hospital, Detroit, as an emergency (No. 10667), with a diagnosis of septicæmia. She was 36 years of age, the mother of six living children.

The patient had been delivered of a dead child at term, seven weeks previous to her entrance to the hospital. Five weeks before entrance she had had a dilatation and curettage, and since then she had been confined to bed with a fever. She had had pain in the lower abdomen for five weeks. While in the hospital, an intermittent temperature, ranging from normal to 104.4° was noted; the pulse was rapid and she had a shaking chill each day, lasting half an hour or more. The physical examination was negative except for a soft blowing systolic murmur heard at the base of the heart, a marked anæmia and a lemon-yellow pigmentation of the skin. The spleen and liver were not palpable. Blood cultures and the Widal test were negative. The red blood-cells were 1,200,000, whites 4,850, hæmoglobin 25 per cent Sahli, polynuclears 49 per cent, mononuclears 51 per cent. The transfusion of 400 cubic centimeters of blood (Unger method), by Willard D. Mayer, produced a remarkable improvement in the patient's condition for 36 hours, when she again had a recurrence of the chills and high temperature. She expired on the fifth day following her entrance into the hospital. At autopsy there was found a pelvic abscess and many metastatic abscesses in the lungs and other viscera. The bone marrow was pale and showed signs of depletion.

The Wassermann reactions on the first three patients were negative. Blood cultures were taken from the third and fourth patients on several occasions, but nothing was found. They all had heart murmurs. The first patient was thought to be suffering from an endocarditis of the aortic and mitral valves; but as the illness had followed confinement, puerperal anæmia was suspected. Following the first transfusion, the diastolic murmur and the vascular signs of aortic insufficiency disappeared. One year and three months later, the heart was normal. There were no murmurs heard a year later during the examination of the second and third patients. The murmurs therefore, were thought to be hæmic in origin. The hyperresonance of the lungs, which was noted in every patient, disappeared following transfusion.

It will be seen that all the patients except the last had normal confinements and that none had hæmorrhages. Each patient had had one or more pregnancies. None of them had a leucocytosis and all ran an irregular temperature.

The blood smears were interesting. A leukopenia and a relative increase in the lymphocytes was present in each case; the first and second patients showed a high color index with poikilocytosis in the extreme, moderate anisocytosis, numerous nucleated red cells of which an occasional one proved to be a megaloblast. There was slight polychromasia. No macrocytes were seen in any of the smears. These blood pictures differ from those of primary pernicious anæmia in one very important respect; the absence of macrocytes. In the cryptogenic form of anæmia, macrocytes are present in

numbers, averaging at least 25 per cent. The smears from the second and fourth patients resembled those seen in cases of the aplastic type of anæmia; marked poikilocytosis, some anisocytosis, a leukopenia, but no polychromasia or nucleated red cells.

Puerperal anæmia was first described by an American, Walter Channing, in 1842 (3). The number of recorded cases, confined mostly to the French and German literature, is not very large; but reports have been made with increasing frequency in the past few years. Also, in most instances, the records are very incomplete, and the cases reported have been poorly studied. In many, no blood examinations were made at all, and frequently only the leucocytes were counted and the hæmoglobin taken. Nagli (4) and his associates have reported seven cases with autopsies. These are by far the best records I have been able to find.

An examination of the literature, which includes about 138 references, shows that the disease is rare, though many cases are in all probability never reported. If one excludes all the cases frankly due to sepsis, the disease, as such, would be extremely rare. It occurs most frequently between the ages of 20 and 40, but no age is exempt during genital life. Over 70 per cent had had more than one child. In 80 per cent the anæmia was first discovered following delivery, hence the term puerperal anæmia.

The symptoms first observed in their order of frequency were: palor, vomiting, diarrhœa and bloating, but always sooner or later asthenia becomes the chief complaint of most patients.

The spleen was palpable in about 30 per cent of the cases. Murmurs were heard over the heart in every case where that organ was mentioned as examined, therefore this may be the reason why the disease, in its incipiency, is so frequently mistaken for endocarditis. Pigmentation of the skin was observed in over 50 per cent of the cases. Increased respiration or dyspnœa was frequently recorded as the chief complaint. Many of the patients had hæmorrhages into the retinæ, but in most instances the eyes were not examined. Symptoms due to cord lesions have never been reported to my knowledge. Hydrochloric acid is often diminished and occasionally absent in the gastric contents. Hæmorrhages occur, but appear to be due to the same etiological factors as that which produces the anæmia. Ninety-seven per cent had fever during some period of their illness and in over 50 per cent it was continuously irregular. Approximately 68 per cent had a leucocytosis of 10,000 or above. In 28 per cent the leucocytes were below 6,000 per centimeter.

The prognosis is bad, as 87 per cent of the patients die (5). Where the condition had been suspected before term, abortion, spontaneous or induced, had no influence in improving the disease; also the severity of the anæmia was of little value in determining the prognosis.

The reported autopsies show little other than what one would expect to find in any severe anæmia; fatty degeneration, red or aplastic marrow, as the case might be. I could find no instance where disease of the spinal cord has been reported. Where an infection had been proven at autopsy, endometritis was the common finding, usually of the diphtheritic type. Endocarditis has been reported in a few instances and syphilis has complicated the picture only occasionally. It may also be noted that nothing has been found in the blood sera of these patients which would explain their anæmia.

DISCUSSION

There is little evidence in the literature to support the statement (2) that the disease usually begins during pregnancy. On the contrary, it is most frequently observed following delivery. The severity of the anæmia, the high color index, the leukopenia and the presence of nucleated red cells, especially megaloblasts, have been responsible for the confusion of this disease with pernicious anæmia. But we now know that megaloblasts occur in many forms of anæmia, and I have seen them in smears from cases of pneumonia without anæmia. The diagnosis of pernicious anæmia should be made with caution when macrocytes and a leukopenia are not present. Pernicious anæmia is a

severe form of anæmia, which after one or more remissions ends fatally, and it develops as a primary disease without a demonstrable cause in both men and women. We should hold steadily to this conception of the disease, and should separate it from those forms of secondary anæmia, which produce a somewhat similar blood picture. Puerperal anæmia should certainly not be confused with primary pernicious anæmia and I believe there is little excuse for confusing the blood pictures of these two conditions. The absence of macrocytes and the frequent leucocytosis may serve to differentiate it. Other differences are the lack of remissions and especially the absence of cord lesions. It is, of course, possible for pernicious anæmia to be complicated by pregnancy, and this may occasionally cause confusion.

From a study of the cases so far reported, one would be inclined to the opinion that an infection was the most probable cause of the anæmia. In less than 20 per cent there was no evidence of infection other than fever. Blood cultures have been negative repeatedly. They were twice negative in our last patient, nevertheless an infection was proven at autopsy. This patient had a leukopenia, a high color index and a severe poikilocytosis. The literature abounds with descriptions of such blood pictures diagnosed as pernicious anæmia.

The theory of a toxic cause for puerperal anæmia has many supporters, among them Grawitz (6), Sachs (7) and others. This doctrine of a toxin produced within the uterus by the pregnancy and causing an anæmia in the mother is not well supported by the facts. It has been demonstrated conclusively that the removal of the uterine contents has no beneficial effects upon the course of the disease; in fact, in the small number of reported cases where the illness has definitely begun during pregnancy, induced abortion has had a most unfavorable effect. Furthermore, it is most frequently seen in its severest forms following delivery.

Another view (8), advanced as a cause of the anæmia, is a disturbance of the glands of internal secretion. In certain instances this hypothesis seems plausible, especially is it applicable in those cases where an autopsy has proven nothing but an anæmia with its concomitant changes. On the other hand, these cases are few and there has been no convincing evidence to prove that puerperal anæmia is not the result of an infection. The present tendency is to push the intoxication theory too far.

In most instances the confinement is recorded as normal and the child living and well. The children of the first three patients herein reported are living and in good health, and so far as we know, were normal at birth. No blood examinations were made on the children, as it apparently was not indicated at the time. Blood examinations from the child at birth have been reported by Spire and Perrin (9), also by Jungmann (10) in a case of von Jakach's anæmia.

In conclusion, it should be stated that too much emphasis cannot be put upon the importance of the life saving effects of the transfusion of blood in these patients. The rapidity with which the anæmia can develop is surprising and the mortality reported is appalling. It is therefore urged that transfusion should not be used as a measure of last resort, but early, as soon as the diagnosis can be made. Treatment with drugs is frequently useless but they should not be abandoned, particularly after transfusion when arsenic and iron are often efficacious.

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GONORRHŒAL EMPYEMA

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IN a review of the literature on pleurisy and empyema of the chest due to the gonococcus, it was found that up to May, 1913, only sixteen authentic cases have been reported.[1] Since that time I have been unable to find any further cases in the literature. Therefore I have thought it worth while to add my case to those already on record.

Although the gonnoccocus has a very wide distribution, and in cases or septicæmia due to the gonococcus one often sees the serous membranes attacked with a resulting endocarditis, pericarditis, peritonitis, meningitis, or arthritis, yet the pleura is very rarely involved.

M. M., a white girl eight years of age, was admitted to the University of Virginia Hospital on November 10, 1917, complaining of pain in her abdomen. The family and past history was unimportant. Five days before admission to hospital the patient was seized with a severe cramp-like pain over the whole abdomen, being most severe over the lower half. For 24 to 48 hours she suffered to a considerable degree, then the pain became somewhat better under the use of local applications. She got along very well until the day before coming to the hospital, when the pain returned with marked severity; at this time it seemed to be most pronounced in the right lower abdomen, but was present also to some extent in the left side. There had been no nausea or vomiting up to this time, but on taking a purgative she vomited promptly and vomited once later. The patient gave no history of previous similar attacks.

Physical examination showed the patient to be well nourished and well developed; she was evidently suffering, and looked ill. The abdomen was moderately distended, with muscle spasm and marked tenderness over the lower half, somewhat more pronounced on the right side. There was no dullness, and no masses. Heart and lungs were normal. Rectal examination was negative. Temperature on admission was 103.4°; leucocytes 28,000. The diagnosis of general peritonitis was made, and at that time it was thought probable that a ruptured appendix was the cause. The child was operated upon immediately, and on opening the abdomen there escaped a thin, cloudy pus, without any disagreeable odor. The omentum was found to be adherent over the right brim of the pelvis and the appendix was found in this region also. The appendix was freed with little difficulty. The tip of it was somewhat thickened and covered with fibrin, but it showed no perforation and did not seem to be obstructed. The appendix was thought to be the cause of the peritonitis, and the offending organism some form of the streptococcus, which had gone through the wall without leaving any definite sign of perforation. Drainage was instituted and the abdomen was closed without any further examination of the viscera, as the child was very ill and it was thought best not to prolong the operation.

Following the operation the clinical course of the disease was that of a general peritonitis. The abdomen became moderately distended and showed general tenderness. The patient suffered from cramp-like pains, but never vomited nor did she seem nauseated. The temperature ranged from 101.5° to 105.5° and the patient presented the appearance of severe toxæmia. On the sixth day after operation there were signs of a pneumonia or an accumulation of fluid at the base of the right lung posteriorly. On aspiration of the right chest there was obtained about 2 cubic centimeters of a thick yellow pus. From this finding it was thought that the child had a right-sided empyema, and that this might be causing the high temperature and severe toxæmia.

She was then operated upon a second time and a thoracotomy of the right chest done. When the chest was first opened no pus could be demonstrated, but when the child was turned flat on her back a few cubic centimeters of pus flowed out of the wound.

The respiration immediately rose from 30 to 48 and the child died in twelve hours from what seemed to be a respiratory failure. No autopsy could be obtained.

On the second day after the first operation the child was found to have a profuse, yellowish vaginal discharge, and on examination of smears made from this there was found only the gonococcus, the diagnosis being made from the morphology and staining characteristics. Smears made from the pus obtained at the time of aspiration and at the second operation showed again the gonococcus. A blood culture was made on the sixth day after the first operation, using special media, was negative An attempt was made to grow the organisms seen in the pus from the chest but all the cultures remained sterile.

[1] Norris, Gonorrhœa in Women. Philadelphia: W. B. Saunders Company.

COMMONER LESIONS PRODUCING BACKACHE[1]

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OUR knowledge of all pathological conditions has been advanced mainly by observations made at the necropsy table and in the surgical amphitheatre. For this reason our knowledge of certain fields is limited, where pathological conditions and anatomical variations are closely allied; and particularly is this true should the field be outside the route of the more common surgical procedures.

One of the most important and neglected of these fields, both from the surgical and pathological standpoint, is the back, the region most frequently affected lying between the first lumbar and last sacral vertebra.

Pain in this region may be caused by diseases of the pelvic organs, a myositis of the lumbar muscles, renal colic, ureteral and urethral stricture, lesions of the spinal cord and vertebræ, sacrum and ilium. It is particularly to the sacro-iliac and sacrolumbar pain that I wish to call your attention.

Among orthopedists the sacro-iliac articulation is now classified as a true joint. It has the function, structural characteristics, and is subject to all the diseases and accidents of the same. The sacrum acting as a keystone, tightly bound in place by strong ligaments, makes this joint less vulnerable to ordinary types of attack.

Langnecker[2] classifies lesions of these joints as toxic, static and traumatic. The toxic group includes those lesions produced as a result of constitutional diseases, such as syphilis and tuberculosis, metabolic disorders, focal infections and infectious diseases. It is mentioned here only for purposes of differential diagnosis. These cases are characterized by pain of a burning, aching character, which is first noticed on pressure. It is not relieved by change of posture. Location of lesion, history of infection, onset, temperature, and laboratory findings assist in the diagnosis.

The static group includes those cases, practically always bilateral, which are not associated with infections and arise entirely as a result of posture. Among the predisposing causes are hard labor, visceroptosis, pregnancy, lordosis, coxa vara, in fact, anything which tends to alter the center of gravity. These factors increase the ligamentous strain with gradual relaxation, thus producing increased mobility of the joint. A common and acute cause is the complete muscular relaxation on the operating table produced by a general anæsthetic.

The traumatic group is characterized by sudden onset following direct or indirect trauma, such as a sudden twist when out of balance, acute unilateral direct strain, falls on the buttocks or feet, difficult parturition, etc. The pain is sharp, lancinating in character, follows immediately after the injury, and is increased by motion. It is of greatest intensity over the affected joint, may radiate upward but frequently downward along the course of the sciatic nerve, and occasionally is referred to the opposite side.

On inspection the lumbar curve is diminished or obliterated. The patient walks with a forward stoop, lists to one side, and usually carries the hand over the joint involved, making every effort to immobilize it. On sitting down he slides into the chair sidewise. The roentgenogram shows a difference in the angles of the ilia in their relation to the spine. Sometimes there is a visible separation of the sacro-iliac joint.

Proper reduction with temporary strapping confirms the diagnosis by relief of pain, which is usually immediate.

Other potent etiological factors of painful back are the anatomical anomalies, particularly of the transverse processes. Adams[3] reports a study of 50 consecutive cases in the Massachusetts General Hospital, in which careful roentgen examinations were made.

[2] Langnecker, Harry L. Lesions of lumbosacral and iliac region. J. Am. M. Ass., xlv, 1886.

[3] Adams, Z. B. The relation of bony anomalies of the lumbar and sacral spine to the cause and treatment of scoliosis. Am. J. Orthop. Surg., 1914, xii, 45.

[1] Read before the Chicago Surgical Society May 3, 1918. (For discussion see p. 633.)

Of these, 44 showed bony defects in the sacrum or fourth or fifth lumbar vertebræ; 7 showed anomalies of the fifth lumbar inferior articular process, and 2 of the transverse processes. At this ratio, though, the condition is not a common one; it behooves us to be on our guard and not make the all too frequent diagnosis of lumbago, sciatica, or rheumatism.

Hoping to gain some useful information from the cadaver, I have carefully studied this region in 26 dissected cadavers, with particular reference to arthritis of the joints; bursa; the relation of the lumbosacral cord from its exit through the intervertebral foramina, downward over the brim of the pelvis; and the transverse process of the last lumbar vertebra, their size, shape, and relation to the surrounding structures. From cases of this study, I found in two cases definite arthritis of the sacro-iliac joint, and in none of the cases could I find evidence of a bursa. The one constant finding was the relation of the lumbosacral cord lying, as it does, directly on the bones of the linea innominata, thus accounting for Oppenheim's [1] remarkable observation that in all cases in which compression or other injury affects the sciatic nerve in the pelvis, the paralytic symptoms are most marked in the peroneal nerve. The transverse process of the last lumbar vertebra varied from 0.5 to 4 centimeters in length, and varied in shape from a simple pointed projection to the large fish tail process not infrequently seen in roentgenograms. The simple pointed process seems to predominate, as it was found in nineteen of the cadavers. One had the large fish tail type on both sides, three had the simple-pointed process on one side and the fish tail on the other, while another had the fish tail process on one side and a broad pointed process on the other.

The so-called fish tail spine was first thought to be a pathological condition, as evidenced by Henderson's [2] article on "Bifurcation of the Transverse Process of the fifth Lumbar Vertebra." Further investigation has not borne out this fact, for this type of process is frequently seen in roentgenograms of the back and pelvis, without, as Henderson states, causing any symptoms whatsoever.

Fig. 1. Dissected pelvis showing the nerves passing over the pelvic brim with entire absence of soft tissues to protect them from irritation.

The distance between the process and the ilium varied from complete bony union, in two cases, to a distance of 6 centimeters, while the distance to the sacrum varied from complete bony ankylosis to a distance of 6 centimeters, where the process was well above the iliac crest.

The anomalies of the transverse process which become pathological, seem to develop during years of hard labor, especially in people following occupations requiring unnatural posture during the adolescent period; such as woodchoppers, shovelers, automobile repairmen, sailors, linemen, washerwomen, etc. It is naturally found more commonly in the male during middle adult life. Direct traumata, with laceration of the sacrolumbar and iliolumbar ligaments or a fracture of the transverse process, occurs as etiological factors. Cases recently examined show that both conditions occur, and one case showed a fracture with complete separation and non-union of the transverse processes on one side, of the second, third and fourth lumbar vertebræ. Undoubtedly, infectious diseases bring about changes in this locality, as in one case of general paresis recently examined (also shown in cadaver 3), which had an exostosis along the sacro-iliac articulation, and ankylosis of the transverse process to the ilium and sacrum. When alive, this man undoubtedly manifested

[1] Oppenheim. Text Book of Nervous Diseases. Vol. 1, p. 461.
[2] Henderson, M. S. Am. J. Orthop. Surg., 1914, xii, 54.

Fig. 2. Segmented sacrum. Definitely determined only by roentgenogram which includes all of the lumbar vertebræ. Note the entire absence of any transverse processes.

Fig. 3. Unusual type of transverse process. Symptoms manifest after an accident which fractured the iliac crest near the process in the left side.

symptoms, as there was a decided atrophy of the gluteal and peroneal groups of muscles.

The factors involved in the production of pain seem to vary. The transverse process may impinge on the ilium and, acting as a fulcrum, separate the sacro-iliac joint. As in the case of Adams,[1] an erosion of the ilium may occur from constant friction. Hyperplasia of the soft tissues, from irritation, may involve the nerve, or the transverse process may act as a cervical rib acts upon the brachial plexus.

The pain is located in the back directly over the process. It may radiate upward into the back, or downward to the sciatic notch, or calf of the leg, and the inner surface of the foot and great toe. There may be some atrophy of the gluteal muscles and the muscles of the back of the leg. Changes in the reflexes, sensation, and compensatory curvature of the spine all depend upon the length of time the process has been active. Advanced cases are not infrequently taken for beginning Pott's. One case, reported by Goldthwaite,[2] was operated upon for a tumor of the cauda equina, and in reporting the history of one of my own cases a neurologist was very certain, up to the time of the operative report, that I was dealing with such a tumor. It remains, in all cases, for stereoscopic roentgenograms to fix definitely the diagnosis.

[1] Adams, Z. B. Am. J. Orthop. Surg., 1910, viii, 299.

[2] Goldthwaite. The lumbosacral articulation. An explanation of many cases of lumbago, sciatica and paraplegia. Boston M. & S. J., 1911, clxiv, 365.

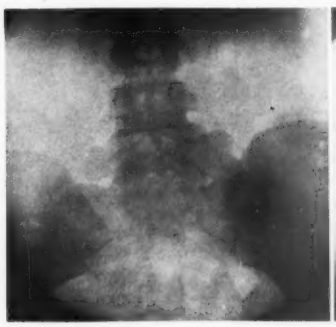

Fig. 4. Process articulating with the sacrum on the right side.

Fig. 5. Process articulating with both sacrum and ilium on the left side.

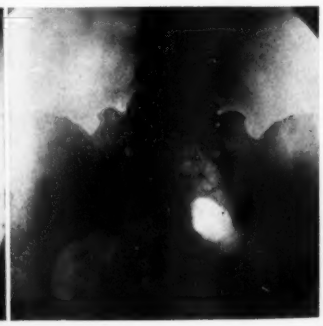

Fig. 6. Trophic change in a case of taboparesis.

Treatment naturally resolves itself into constitutional, palliative, and radical surgical procedures. Naturally, we believe that after ruling out constitutional diseases, the treatment is essentially surgical and the only reason more work has not been done along this line is due to our unfamiliarity with pathological conditions. In acute sacro-iliac subluxations, or fractures of the transverse processes of the last lumbar vertebra, or lacerations of the sacrolumbar or iliolumbar ligaments, no doubt proper manipulation, with the application of a cast, is indicated. In the chronic conditions, belts, girdles, corsets, and casts bear practically the same relation in the treatment of these diseases, that the application of a truss bears in the treatment of hernia. Though operative procedures in this region are not particularly easy, they are not unduly hazardous. And as we become more familiar with the pathology, I am sure we will apply surgical measures for the fixation of relaxed sacro-iliac joints, and the removal of impinged fifth lumbar transverse processes, in the same manner we now do herniotomies in preference to fitting trusses.

A REMARKABLE RESULT IN OSTEOMYELITIS OF CARPUS

By DUDLEY H. MORRIS, M.D., New York
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ALL those who have followed the postoperative course of osteomyelitis are aware of the extreme chronicity which these cases frequently show. The slow, persistent involvement of new areas of bone with resulting sequestration, the obstinate sinuses and the recurrence of pyogenic foci may extend over years during which the organisms lie dormant in the tissues, only exciting acute inflammatory signs when the drainage is obstructed. Many of these cases remain well following the removal of sequestra; but in others the disease persists with a tenacity which defies the utmost surgical skill and which constitutes a serious challenge to medical science. It is in the hope that the intensive study of a single case may serve to throw some light on the pathological processes at work in all similar conditions, that the present case is reported.

Mary C., age 24, domestic. In 1910 patient ran a needle into palm of right hand on its ulnar aspect. The wound healed. The patient had no further trouble until 1912 when she entered the Presbyterian Hospital with cellulitis of the right ring finger and ulnar aspect of hand. She was operated upon and a fragment of needle removed from space between fourth and fifth metacarpals, adjacent to ulnar bursa. Another incision was made over the dorsum of the proximal phalanx of the fourth finger. The infection did not subside and a sinus remained which refused to heal.

In May, 1913, the condition was about as follows: The hand was markedly swollen, red, and tender, especially on its ulnar side. The fifth finger was red, tender, and swollen to its tip; there was a sinus 1 inch proximal to the fourth web which extended proximally toward the hypothenar eminence and distally to the anterior aspect of the proximal phalanx of the fifth finger beneath the tendon (tenosynovitis?). The X-ray showed a beginning osteomyelitis of the proximal phalanx of the fifth finger. The hand was repeatedly dressed but was not relieved. The sinus tract was incised, the granulations curetted, and the wound drained. No pus was obtained. Histological report, granulation tissue. No evidence of tuberculosis was found. The inflammation now subsided somewhat but the sinus in the palm still persisted. During the following two months the finger remained swollen and tender, and there was periodic increase in the inflammatory signs.

In October, 1913, the fifth finger together with the head of the fifth metacarpal was amputated by Dr. St. John. Skin flaps were loosely approximated with silkworm and a 1 per cent formalin dressing applied. Following the operation, the redness and swelling increased on the dorsum of the hand and on the ulnar side of the fifth metacarpal. The wound healed slowly and the sinus persisted in the line of incision. Nearly all known methods were tried in the effort to get this to close, but none was successful. The X-ray showed osteomyelitis of the lower end of the fifth metacarpal, and in the course of a month several sequestra appeared with marked periosteal thickening of the lower half of the bone (Fig. 1). By

Fig. 1.

Fig. 1.

Fig. 1. Roentgenogram 1 month after amputation of right fifth finger and lower extremity fifth metacarpal, showing sequestration and beginning osteomyelitis.

Fig. 2.

Fig. 2.

Fig. 2. Roentgenogram 6 months after amputation of right fifth finger showing advance of osteomyelitis which now involves entire fifth metacarpal. Larger sequestrum.

January 1, 1914, the bony lesion had progressed to extensive osteomyelitis of the fifth metacarpal which however, remained more or less quiescent for the next six months. During this time, the bone progressively enlarged and the disease extended to its proximal extremity. The palmar sinus continually discharged foul-smelling pus from which a culture yielded staphylococcus and a gram-negative bacillus, probably bacillus coli (Fig. 2.).

In August, 1914, the patient entered the hospital and an ostectomy of the fifth metacarpal was done by Dr. Darrach. A culture from the bone showed staphylococcus aureus and a gram-negative bacillus, probably colon bacillus. Sections showed only granulation tissue, no tuberculosis being found on careful search. The Wassermann reaction was negative.

On October 8, 1914, the X-ray (Fig. 3) showed some involvement of the right unciform, which indeed

Fig. 3.

Fig. 4.

Fig. 3. Roentgenogram 6 weeks after ostectomy of fifth metacarpal showing beginning osteomyelitis of unciform.
Fig. 4. Roentgenogram 6 months after ostectomy of fifth metacarpal showing extensive osteomyelitis of carpus.

Fig. 4.

Fig. 5.

Fig. 5. Roentgenogram 1 year after ostectomy of fifth metacarpal showing quiescence of osteomyelitis and ankylosis of most of carpal bones.

Fig. 6.

Fig. 6.

Fig. 6. Roentgenogram 9 months later showing approximately same condition as in last plate.

Fig. 7.

Fig. 7.

Fig. 7. Roentgenogram of wrist immediately following injection of bismuth.

could be detected in earlier roentgenograms. Sinuses were present in the line of last incision and over the ulnar aspect of the wrist. In the succeeding six months the entire carpus showed extensive osteomyelitis (Fig. 4). There was redness, swelling, and tenderness of the entire wrist and over the lower ends of the radius and ulna. The sinuses continued to discharge fœtid pus and could not be closed. Numerous methods were tried, including baking, massage, heliotherapy, immobilization, irrigation, carbolization, and passive congestion; all without avail. The patient refused to consider amputation above the wrist, and the process became stationary in about the condition above described. The patient was unable to do any work and dressings had to be renewed every few days.

In February, 1917, when I first saw this case, there had been very little change from the condition in the early part of 1915, except that an ankylosis had taken place between some of the carpal bones. The physical examination at this time was as follows:

The right wrist was markedly swollen. There was moderate redness and tenderness over the dorsum of the wrist, over the styloid process of the ulna and anteriorly opposite the remains of the scaphoid. Tenderness extended for a short distance up the radius. There was a marked fibrous ankylosis of the wrist. The fingers were boggy and swollen though not red or tender and there was only slight power of flexion. The patient was unable to do any work. On the ulnar side of the wrist there was a sinus discharging a thin foul-smelling pus, which, however, was rather scanty in amount. A probe passed into this for a distance of nearly two inches to a point just below the lower extremity of the radius. Here was a large irregular cavity corresponding to the wrist-joint at all parts of which the probe touched bare roughened bone. There were apparently no loose pieces of bone. The roentgenogram taken at this time showed extensive osteomyelitis involving all the carpal bones with ankylosis of the scaphoid, semilunar, os-magnum, trapezoid, and trapezium. The lower ends of both radius and ulna showed irregular roughening and erosion, as did the bases of the third and fourth metacarpals. There was a very irregular cavity corresponding to the wrist-joint which apparently had prolongations between the individual carpal bones and between the radius and ulna. No obvious sequestra could be made out (Figs. 5 and 6).

The patient was rather pale and anæmic and weighed 118 pounds, but did not feel sick. No cough. The temperature was normal. No other pathological conditions were made out. Cultures from the sinus showed repeatedly the presence of staphylococcus aureus and a gram-negative bacillus having many of the characteristics of colon bacillus.

From February 1, to May 1, we ran the gamut of nearly every known therapeutic procedure, in the effort to cure this patient. She had among other things 3 exposures to twenty milligrams of radium for half an hour each, the tube being introduced into the sinus. No effect on the process was noticed. Continuous irrigation with Dakin's solution was tried with transient benefit; Churchill's iodine, phenol, iodoform-glycerine, and other strong antiseptics were introduced into the sinus cavity without result. Curetting sinus, baking, immobilization, autogenous vaccines, heliotherapy, hygienic measures

Fig. 8. Fig. 9. Fig. 9.

Fig. 8. Roentgenogram 6 months after injection of bismuth paste. Patient well for 5 months.

Fig. 9. Roentgenogram 8 months after injection of bismuth. Patient well and at work for past 7 months.

including forced feeding and open air treatment, these and other methods were tried without there being the slightest permanent improvement. Finally on May 1 an injection of bismuth subnitrate (Beck's paste) under considerable pressure (sufficient to distend the wrist-joint and fill all the crannies) was tried. Following this there was a marked reaction accompanied by redness, swelling, and some œdema of the wrist. The patient complained of pain sufficient to keep her awake. Apparently the injection had started up a certain amount of cellulitis. A large aluminum acetate dressing was applied and this process gradually subsided. Four days later there was no redness and very little pain. The sinus remained open superficially; but there was no discharge. A roentgenogram taken at this time showed the bismuth filling the wrist-joint and extending in narrow tongue-like processes through all the ramifications of the very irregular cavity. Between the carpal bones, between the radius and ulna, and between the metacarpals were extensions of the bismuth (Fig. 7).

After about two weeks the wrist had shrunken to its original size and there was no tenderness. The now very minute sinus remained open, discharging a few drops of serum for another three weeks until it was obliterated by the pressure of a small strip of adhesive plaster. Since that time the sinus has remained closed and the patient is cured. She has remained free from pain or recurrence, has been able to do her work (laundry) for the past eight months and there seems no reason to believe that she will have any further trouble.

Roentgenograms taken from time to time since the sinus closed show a gradual absorption of the bismuth, which is apparently being replaced by granulation tissue. The bony component is about as it was before the injection (Figs. 8 and 9).

I consider this case to have been cured by the obliteration of dead spaces, which previously formed a fertile field where the bacteria could develop out of reach of the defensive mechanism of the body, and yet where their toxins could act upon the tissues. The organisms being of low virulence, as soon as subjected to the bactericidal influences of the tissues and the bismuth, succumbed.

NASAL REFRACTURE

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BETWEEN July 14, 1915, and June 10, 1917, two thousand prisoners entered San Quentin Prison. All of these men were given a careful physical examination on their arrival.

An analysis of these two thousand cases shows, among other interesting findings, that 15 per cent of them have deflected nasal septa. Some of these septa are sufficiently bent to cause permanent nasal obstruction, while others are of less degree and cause mouth breathing only when the turbinate bones become swollen or there is other nasal congestion.

Eleven per cent of the prisoners examined have deformed noses, comprising those with depressed bridge or deflection to the right or left. Very few of the deformities were congenital, most of them being traumatic, caused by blows on the nose received in fights or accidents.

For the correction of the septal deflections, submucous resection is the operation of choice and yields excellent results as to function. For the deformed noses, however, there are numerous operations, each one varying according to the peculiarity and degree of the deformity. These operations are for the most part long, tedious, and not always satisfactory.

Good results not having been obtained with the knife, curette, or chisel by intranasal procedure for noses which had been broken to the left or right, another plan was devised.

It was reasoned that for the most part these deformities had been caused by a blow on the nose producing a fracture. This fracture may have been through one or both nasal processes of the superior maxillary bone, or it may have been a dislocation and possible overriding of the two nasal bones, dislocated at their sutures with the frontal bone and the superior maxilla. At the time of the accident the fracture was probably not well reduced and had healed, leaving an unshapely and unsightly nose.

A study of a number of recent fractures of the nose among the prisoners revealed this to be the fact. One inmate with homicidal intent struck at the head of another

Figs. 1, 2, and 3. Patients before and after operations.

Fig. 4. Plaster casts of face before and after operation.

with a four-pound sledge hammer. Luckily the recipient of the blow dodged as he saw the sledge coming and received the full force of the blow along the right side of the nose, fracturing the nasal processes and comminuting the nasal bones. Another prisoner was struck with a baseball on the nose. This blow merely unloosened the nasal bones and slid them over to the left, as shown in Fig. 6. Other similar accidents have shown the soundness of this reasoning.

The method devised for correcting these old standing conditions is to apply a sufficiently heavy blow to the nose to refracture it and return it to proper shape.

The process of refracture is as follows: After the standard preliminary preparation, the patient is given an anæsthetic of nitrous oxide or ether rausch. As soon as the patient is under the influence of the anæsthetic so that he will feel no pain, the operation may be begun.

A cylindrical piece of wood (one inch in diameter by six inches long), well padded on

Fig. 5. Paulson form for pouring plaster casts.

Fig. 6. Before and after operation. Patient had been struck with baseball. The blow loosened the nasal bones and slid them over to the left.

the contact surface, is placed against the convex side of the nose, that is, the side of the nose opposite to which the original causative impact was applied.

With several strokes of a mallet on this buffer, the nose is refractured, and may then be restored to its original position.

Sometimes it is necessary to insert a blunt periosteal elevator into the nasal fossa to lift the nasal bones up or to press them outward.

Due to the blow of the mallet, there may be some bleeding, but this is quickly stopped by packing both nasal fossæ with thin strips of bandage previously boiled in petrolatum.

The light anæsthetic having been stopped as soon as the operation is begun, the patient very soon regains consciousness, and is able to expectorate any blood which becomes accumulated in his throat.

As soon as the packing is in the nose, a cofferdam of pasteboard is placed around the nose, extending across the upper lip, up on either side of the nose, and up to the forehead. Plaster of Paris is mixed into a moderately thick mass, and then poured over the nose and upon the forehead, being prevented from escaping by the cofferdam.

The plaster soon sets, making an excellent cast which holds the nose in good position. This cast is then anchored with two strips of adhesive, one from malar to malar, and the other across the forehead. By this time the patient is able to walk back to the ward. The whole operation usually consumes less than fifteen minutes, including the anæsthetic.

Twenty-four hours after operation the packing is removed from the nose, and the cavity sprayed with some mild antiseptic solution. The cast is worn for from two to four days, and upon removal usually a good result is shown. The plaster directly in contact with the skin causes no disturbance for this length of time. In a former paper,[1] the use of collodion splint was advocated, but the plaster is now considered more satisfactory.

Pictures of the face are taken before and after the operation (Figs. 1, 2, 3) and in order to better study the results, death masks (Fig. 4) are also made. To make plaster casts of the nose it is first necessary to have the patient lie on his back. The face is then covered with a coating of vaseline, being careful to have the eyebrows and eyelashes well greased.

[1] The Laryngoscope, 1917, Jan.

A metal form (Fig. 5) is then placed over the face extending across the upper lip to the cheeks and malar bones, and to the forehead. In case the form does not exactly fit, plastic dental wax may be molded about this form where it does not impinge on the face.

Plaster of Paris mixed with water is then poured into the form and allowed to harden. When solidified, the cast may be removed easily from the face. This produces a negative. In order to obtain a positive, it is necessary in turn to grease this form well and pour plaster into it. When the plaster hardens, the two may be separated and an exact reproduction of the face is made.

During the past three years about 49 cases of deformed noses have been operated upon with the refracture method. Most of the results have been excellent.

The technique is simple, and no bad after-results have been encountered.

ACUTE INFECTIVE NEPHRITIS

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AND
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DURING a period roughly covered by the last ten years, a large number of cases of infection in and about the kidney have come under our observation. We hope at some future date to analyze them in some detail. Among these cases are a number which do not properly come under the old term of surgical kidney, nor yet under the various types of perinephritic infection and pyonephrosis. They seem comparable to infections produced by certain pyogenic micro-organisms elsewhere in the body, in that the kidneys show numerous small areas of acute inflammatory reaction which may progress to abscess formation or to some stage or end-result of such lesions.

We have selected a number of these cases for analysis. The work has proven all the more interesting in that the urological literature contains a large number of papers which discuss from various points of view the type of lesion we wish to consider. We have profited by the suggestions and hypotheses given in these papers, and where they seem applicable to our own cases, we have made use of them.

The ability properly to diagnose, and therefore, properly treat surgical conditions of the kidney dates from the introduction of what it has been the custom to refer to as the newer urological methods, viz., the use of the cystoscope, ureteral catheter, functional tests, pyelography, etc. Indeed, without these aids, it is scarcely possible to make a diagnosis even reasonably certain, much less a diagnosis on which one can safely act. That the kidney

[1] Since this paper was written Lieutenant Colonel R. P. Campbell, C.A.M.C., has been killed in the Battle of the Somme.

conditions we are to deal with have come into prominence only within the past few years is probably due to the fact that only during this period have we been able to diagnose them in their earliest stages. Such cases as did succumb as a result of these conditions and came to postmortem, did so in most instances only after the kidney had been largely destroyed or the disease advanced to such an extent that the early picture of small areas of acute infection with, or without, miliary abscesses was lost, and that of "surgical kidney" or perinephritic abscess substituted for it.

Out of a series of 126 cases of various types of infected kidneys exclusive of tuberculosis and those secondary to stone, we have selected for analysis or reference two groups:

Group one. Infected kidneys which were diagnosed clinically by means of the ureteral catheter and by the use of the more recently developed urological technique, and in which the clinical diagnosis was corroborated by operation and bacteriological and histological examination of excised kidney tissue, or the entire kidney when this was removed. This group consists of 44 cases.

Group two. Infected kidneys diagnosed in a manner similar to those in Group One, but lacking the confirmation made possible by operation. This group consists of 56 cases. They are considered in order to elucidate certain points that arise from the discussion of the cases in Group One.

This study is based, however, upon the cases operated upon.

Group one, comprising the 44 cases operated upon, may be divided as follows:

a. Thirty-one cases of subacute or chronic infection, which though we feel that they are in many instances related to the following group, have not been included in it.

b. Thirteen cases of acutely infected kidneys. These cases constitute the material to which we wish to refer in detail, and upon which we would base whatever conclusions seem to us justifiable. To this group is added one case which we did not see until the postmortem.

We have selected certain of these 13 cases for detailed examination.

CASE 1. M. W., female, aged 30 years, was admitted to the Medical Ward of the Montreal General Hospital, into the service of H. A. Lafleur, September 17, 1907, complaining of severe pain in the region of the right kidney. This pain was constant but subject to exacerbations. The pain was accompanied by nausea and vomiting, which had begun on September 8, nine days before her admission to the Hospital. Her temperature ranged from 102–103°F. There had been blood in the urine, but this had disappeared before she entered the Hospital. At the time we saw her the urine contained leucocytes, but no red blood-corpuscles. The urine was turbid, and the bladder required repeated washing before a careful cystoscopic examination could be carried out. The mucosa was reddened, but otherwise nothing abnormal was found. The bladder had a capacity of 300 cubic centimeters. The ureters were catheterized and the flow from each ureter was rapid and equal in amount. One cubic centimeter of a 1 per cent solution of phloridzin had been administered previous to the catheterization of the ureters. The catheters were passed and left *in situ* for three quarters of an hour. The analysis of the urine obtained during this period is shown in Table I.

TABLE I—ANALYSIS OF URINE, CASE 1

	Common	Right	Left
Reaction	Acid	Acid	Acid
Specific gravity	1012	1012	1022
Albumin	+	++	Trace
Urea	——	1.8	2.6
Sugar	–	×	4×
	——	Δ.61	Δ1.46
Pus	++	+++	o
Culture	Bacillus coli (pure)	Bacillus coli (pure)	Sterile
Smears	No tubercle bacilli	No tubercle bacilli	No tubercle bacilli

X-ray examination showed nothing abnormal. In spite of this we made a diagnosis of renal infection secondary to a renal calculus. We were at this time not so familiar with acute infective nephritis.

On September 24, 16 days after her symptoms had first appeared, we cut down on the right kidney, which was found to be enlarged, softer than normal, and united to the adjacent tissues by recent adhesions. The kidney was widely opened, but no stone was found and there was no evidence of obstruction to the ureter. A small selected piece of the kidney was excised for examination. The kidney was then sewed up and drained. A histological examination of the snipping showed an acute suppurative inflammation; the entire section was infiltrated with polymorphonuclear leucocytes.

TABLE II—POSTOPERATIVE ANALYSIS OF URINE, CASE 1

	Common	Right	Left
Reaction	Acid	10 cc. Acid	13 cc. Acid
Color	Turbid	Turbid	Clear
Specific Gravity	—	1012	1022
Albumin	—	+	+
Urea	—	0.6	2.0
Sugar Culture	Δ.75 Bacillus coli	0 — Bacillus coli	0 Δ1.4 Sterile
Microscopical	Much pus No tubercle bacilli	Much pus No tubercle bacilli	Few leucocytes No tubercle bacilli

There were small areas which showed abscess formation.

Following the operation, the patient's temperature rose to 107° F. and she continued very ill with recurring chills, high fever and persistent pyuria. On November 28, one month and four days after her operation, an examination of catheterized specimens of the urine gave the findings shown in Table II.

On December 6, two months after her admission to the Hospital, the right kidney was removed. On histological examination the whole kidney was found to be infiltrated with polymorphonuclear leucocytes, lymphoid and plasma cells, and there were areas which showed small abscesses as well as areas of subacute inflammation.

Recovery was uneventful. She has since married, borne children, and remains well. An examination made during 1913, six years after one kidney had been removed, gave no evidence of disease in the remaining kidney.

CASE 2. A similar case is that of C. B., male, aged 35 years, admitted to the Montreal General Hospital, October 25, 1910 (M. G. H. S–1683–10).

Three months previous to his admission he had suffered from what was diagnosed by his attending physician as an attack of acute cystitis. This was followed almost at once by severe bilateral pain in the back. The pain gradually subsided to a dull ache which has persisted to the present time. On one occasion the pain became colicky in nature, and was referred to the anatomical situation of the right ureter. This colicky pain was accompanied by a chill and sweating. At the time of his admission to the hospital his temperature ranged from 99° to 100° F. His chief complaints at this time were frequency of micturition, dysuria, and pain in the back, chiefly in the region of the right kidney.

On clinical examination he was found to be a thin, rather nervous type of man, but except for the condition of the urine, nothing definite was made out.

Examination of a catheterized specimen of urine from the bladder and each ureter gave the findings shown in Table III.

TABLE III—ANALYSIS OF URINE IN CASE 2

	Common	Right	Left
Reaction	Acid	Acid	Acid
Color	Slightly turbid	Clear	Cloudy r.b.c's.
Specific Gravity	1021	1017	1027
Albumin	+	++	0
Microscopical	A few r.b.c's. Many pus cells No tbc. bacilli	Pus occasional r.b.c.'s	No pus Few r.b.c's. (Traumatic?)
Culture	B. coli	B. coli	Sterile

An X-ray examination showed an indistinct shadow in the region of the right kidney. Here, as in the previous case, a tentative diagnosis of renal stone with accompanying infection was made. On November 7, 13 days after his admission to the hospital, an exploratory operation showed an enlarged left kidney in which there were multiple cortical abscesses arranged in small groups. The pelvis of this kidney was slightly dilated. There was no stone, and the ureter was free. Nephrectomy was performed at once (M. G. H. S-10.580). The entire kidney was carefully cut up and examined; it was found to contain multiple foci of infection which varied from minute areas with slight central necrosis to small abscesses. Most of these areas were in the cortex, though there were a few in the medulla. They were most numerous at the upper pole. Microscopically the foci of infection showed degeneration and varying degrees of infiltration with polymorphonuclear leucocytes and plasma cells. Cultures taken from a number of these areas of infection showed a pure growth of bacillus coli.

The clinical history and pathological findings of these two cases are representative examples of the remaining cases in the series. To us the two cases cited above are examples of acute and subacute infection of normal kidneys. There was nothing abnormal found that could be looked upon as predisposing the organs to infection, i.e., there was no demonstrable localizing cause.

The infection evidently did not come from the bladder. True, cystitis was present in one case, but both kidneys were not affected, as one might expect them to be in the absence of any demonstrable lesion which might lead to the selection of only one of them. We now feel that cystitis when present in these cases is to be looked upon as a symptom rather than as a cause of the disease. It is, in our opinion, more correct to regard the cystitis

as secondary to the kidney infection than the reverse. Indeed, with the removal of the infected kidney in Case 2, cited above, the cystitis rapidly cleared up without further treatment and there was no return of this condition.

We look upon infection in these two cases, therefore, not as an ascending infection, but as an infection carried through some other channel; the blood, or lymph stream. Our reasons for doing so we hope to present later in more detail. As the cystitis, which was present in one of the cases rapidly cleared up after the infected kidney had been removed, and as catheterized specimens of urine from the remaining kidney showed no evidence of acute infection in this organ, it seemed fair to conclude that the infection in the bladder was secondary to the kidney lesion and not that the kidney lesion was secondary to it.

The following case was slightly different from the previous (2).

CASE 3. Mrs. D., 34 years old, was admitted to the Montreal General Hospital November 25, 1911. When seven months pregnant, in June, 1911, she had a sudden attack of dull colicky pain in the region of the left kidney, and subsequently passed what might have been a soft calculus. Her physician informed us that no examination was made of this. This was followed in July of the same year by the passage, without much pain, of two similar bodies, neither of which was examined. On August 19, she had a normal confinement, after which she was well until November 7, 1912, almost a year after her symptoms first developed, when another attack of pain occurred. This attack was more severe than her previous ones, and required morphine to relieve it. The pain was accompanied by a chill, and a rise in temperature to 103° F. This was followed by chills, and the left kidney became palpable and tender. In the course of the next three weeks, the pain and tenderness partly subsided, although the temperature ranged between 100 and 101° F. and the pulse rate between 80 and 88. During this attack no foreign bodies were passed. On physical examination, the left kidney was found to be palpable and tender but not much enlarged; pulse 84; temperature 100° F. Apart from these findings, and the condition of the urine, nothing abnormal was to be made out. Cystoscopy showed a mild grade of cystitis. Indigo-carmine was injected intramuscularly and the examination of specimens of urine obtained from the bladder and ureters gave the findings shown in Table IV.

On November 28, 21 days after the onset of her last attack, left nephrectomy was performed. The kidney removed was enlarged and on casual examination reminded one of an acute hæmotogenous tuberculosis, covered as it was with multiple nodules somewhat similar to miliary tubercles. These lesions proved to be areas of acute and subacute inflammation. Small abscesses were present. Bacillus coli was recovered in pure culture from several of the lesions.

TABLE IV—ANALYSIS OF URINE IN CASE 3

	Common	Right	Left
Reaction	Acid	10 ccm. Acid	No flow, except a few drops. The catheter met an insuperable obstacle near the pelvis of the kidney. The few drops obtained were, turbid alkaline. No indigo carmine. Microscopically pus in large amounts. Pure culture Bacillus coli. No tubercle bacilli.
Color	Turbid	Clear	
Specific Gravity	1013	1008	
Albumin	Trace	0	
Microscopical	Pus ++ No tubercle bacilli	Few red blood corpuscles (Traumatic?) Indigo carmine was present in five minutes	
Culture	Bacillus coli	Sterile No tubercle bacilli	

What is of importance in this case and not in the two cases cited above, was a partial stricture of the ureter, three centimeters from the pelvis of the kidney, and in consequence a definite, though slight, hydronephrosis. This stricture explains the difficulty experienced in catheterization of the left ureter. Recovery was uneventful, except for a temporary obstruction to the right ureter, probably due to a small blood clot resulting from catheterization.

In this case, the clinical course and pathological lesions are almost identical with the former case, with the exception of the stricture of the left ureter, and dilatation of the pelvis of the left kidney. The dilatation of the pelvis of this kidney was not great and the kidney itself, to outward appearances, little damaged by the obstruction to the ureter, yet we feel that in the obstruction, with the accompanying dilatation of the pelvis lay a predisposing cause, which rendered this kidney more liable to infection than was its fellow.

In this connection, it is interesting to refer to the clinical and pathological findings in two cases in which multiple areas of acute infection of the kidney developed during the course of typhoid fever.

TABLE V—ANALYSIS OF URINE IN CASE 4

	Right	Left
Reaction	Acid	Acid
Color	Turbid	Turbid
Specific gravity	1008	1017
Albumin	+	+
Urea	1	2
Microscopical	Many pus cells Many gram negative Bacilli No tubercle bacilli	Many pus cells Many gram negative Bacilli No tubercle bacilli
Culture	Bacillus coli and Bacillus typhosus	Bacillus coli and Bacillus typhosus

CASE 4. Mrs. C. Examined January 21, 1907. This patient had been ill with typhoid fever since November 20, 1906, and had suffered two relapses. Since December 4, her urine had contained pus cells and occasional casts. Both of these had lately increased in amount. The urine from the bladder, carefully obtained by means of a catheter when examined bacteriologically showed both bacillus coli and bacillus typhosus. The ureters were catheterized, and an analysis as shown in Table V made.

The growth of typhoid bacilli was more abundant from the urine obtained from the right kidney than from the left one. Lavage of the kidney pelvis was performed at rather irregular intervals as the patient was very ill. This treatment was followed by considerable improvement in so far as the pus and albumin were concerned, and a subsequent examination on February 2, 1907, showed no typhoid bacilli present in the cultures, although bacillus coli persisted. She died on February 14, 1907.

Postmortem examination showed a bilateral subacute infective nephritis with an acute purulent inflammation engrafted upon it.

The interpretation of the findings in this case as in order to support the theory of ascending infections, would rest chiefly on this fact: that these infections are commonest in women and female children. The presumption might be made that on account of the short female urethra, infection is able to reach the bladder from without and then extend to the upper urinary tract. One might argue thus especially in reference to bacillus coli infections. But cystitis in this case was of a very mild grade.

The following case is of interest in this connection:

CASE 5. This patient, a male, ran a typical clinical course of typhoid fever, and from his blood, bacillus typhosus had been recovered in pure culture. Late in the disease, when convalescence was progressing rapidly and satisfactorily, he suddenly developed chills, septic temperature, and pus in the urine. He rapidly became very ill, and died with signs and symptoms of acute septicæmia.

At the postmortem, the general findings were those common to the convalescent stage of typhoid fever. Both kidneys, however, were studded with miliary abscesses. The character and distribution of these areas were similar to those referred to above. There was no evidence of constriction of the ureters, chronic nephritis or cystitis. Cultures from the heart's blood, abscesses of the kidney, and the urine, gave a pure growth of bacillus coli.

These cases seem to throw light upon the point we have already referred to; that bilateral acute infective nephritis may develop in cases of bacteriæmia, provided the resistance of each kidney is equally lowered. It is also of interest to note that there was no demonstrable predisposing lesion in the genito-urinary system, and that in the very acute case, Case 5, there was no evidence of acute cystitis.

SYMPTOMATOLOGY

The above cases illustrate sufficiently the symptoms to be looked for in the condition under discussion, varying as they do, from those with acute onset with chill, rapid pulse, pain in the back, frequent micturition, often accompanied at the onset by hæmaturia, and always marked by a pyuria of varying degree, to a more chronic type where the chief symptom is, perhaps, persistent pain, in the region of the kidney, and recurring attack of cystitis.

The most constant sign is that of cystitis. Only with the cystoscope and ureteral catheter, can these cases be diagnosed with certainty, however probable such a diagnosis may seem from ordinary clinical observation.

PROGNOSIS

Useful as this series may be as confirming clinical diagnosis, yet it does not yield altogether reliable data as to prognosis. Undoubtedly cases of acute infective nephritis may and do recover without operative interference, as the following one will illustrate.

CASE 6. Mrs. W., aged 40, admitted to Montreal General Hospital October 15, 1912. For one month she had had frequency of micturition and dysuria

TABLE VI—ANALYSIS OF URINE IN CASE 6

	Common	Right	Left
Reaction	Acid	Acid	Acid
Color	Turbid	Sl. turbid	Clear
Specific Gravity	1006	1006	1008
Albumin	++	+	0
Microscopical	Much pus No tubercle bacilli	Much pus No tubercle bacilli	Two leucocytes found. No tubercle bacilli.
Culture	Bacillus coli	Bacillus coli	Sterile.

accompanied by a feeling of distention and soreness in the right side. She was not confined to her bed until after these symptoms had been present for one week, when she developed a rigor, followed by high temperature. Chills have frequently occurred since then. The urine has been cloudy and contained considerable pus.

On examination, there was found a palpable tender mass in the region of the right kidney. Her pulse was 88; her temperature 102° F.

A cystoscopic examination showed the bladder to be considerably inflamed. Analysis of the urine obtained by catheterization gave the findings shown in Table VI.

A diagnosis of right-sided pyelonephritis was made, and it was determined to watch the course of the disease for a time.

Her temperature came down gradually. The mass in the right side gradually diminished, and the urine cleared up somewhat, so that on October 26, nine days after her admission, her temperature was normal. By the 29th of this month, the filtered urine was practically free from albumin, though microscopically a few pus-cells could be found. Between this date, and November 18, 1912, a period of less than one month, two relapses occurred, each accompanied with chill, high temperature, and an increase of pus in the urine. After this date, however, she steadily progressed, and the urine became quite normal and has remained so to the present.

Such a case shows that recovery is possible, without surgical intervention, and we could adduce similar cases. The signs and symptoms in this case were just as acute as some of those which demanded operation. It is equally certain that other cases do not recover without surgical intervention, as is illustrated by the following case:

CASE 7. Mrs. L., aged 30, admitted to the Montreal General Hospital October 3, 1911. She gave a history in all essentials similar to the above, except that the pain was bilateral and in the region of both kidneys. She was thoroughly examined, and a diagnosis of acute bilateral infective nephritis made.

TABLE VII—URINE ANALYSIS, CASE 7, OCTOBER, 1911

	Common	Right	Left
Reaction	Acid	Acid	Acid
Color	Pale, turbid	Pale, turbid	Pale, turbid.
Specific Gravity	1007	1007	1007
Albumin	+	+	+
Urea		.014	.016
Microscopical	Pus in large quantities	Pus in large quantities	Pus in large quantities.
Culture	Bacillus coli No tubercle bacilli	5 ccm. in ¾ of an hour No tubercle bacilli	5 ccm. in ¾ of an hour. No tubercle bacilli

TABLE VIII—URINE ANALYSIS, CASE 7, DECEMBER, 1911

	Common	Right	Left
Reaction	Acid	Acid	Acid
Color	Turbid	Turbid	Turbid
Specific Gravity	1010	1010	1010
Albumin	+	+	+
Microscopical	Pus	Pus Capacity of pelvis 45 ccm.	Pus. Capacity of pel vis 55 ccm.

She refused treatment, and left the hospital. She was readmitted on December 3, 1911, two months after her first admission. At this time, an examination showed that the disease was still present. The two following urinary analyses, as shown in Tables VII and VIII, made upon this case are worthy of comparison.

She continuously refused operation and died with signs and symptoms of septicæmia. A post-mortem was not performed.

From these two cases it will be seen that some will recover without operation while others will not.

CLINICAL ASPECT

In considering the clinical aspect of acute infective nephritis, we wish to refer to three important points: the chief factors which determined the clinical course of the disease; what clinical evidence if any, warrants a prognosis; and the selection of a particular line of treatment.

The former of these, the chief factors which determine the clinical course of the disease, in so far as the kidneys themselves are concerned, we feel is closely associated with either one or both of the following. The

TABLE IX—ANALYSIS OF URINE, CASE 8

	Common	Right	Left
Reaction	Acid	Acid	Acid
Color	Sl. turbid	Turbid	Clear.
Specific Gravity	1005	1003	1008
Albumin	—	Trace	—
Urea	—	0.05	0.6
Microscopical	Pus No tubercle bacilli	Pus No tubercle bacilli	No pus. No tubercle bacilli.
Culture	Bacillus coli	Bacillus coli	Sterile.

kidney is unable to recover from the original infection either because of some local condition, which, as in Case 3 of our series, was a ureteral stricture and the kidney was poorly drained as a result of it, or the original infection may be so acute, so extensive, or so prolonged, that the kidney tissue is damaged to an extent which renders complete recovery impossible. This is well shown in the cases occurring in typhoid fever cited above and in the following case.

CASE 8. Mrs. B., admitted to the Montreal General Hospital September 23, 1909. She was at this time pregnant and had suffered from pyelitis from the sixth month of her pregnancy. In the eighth month of her pregnancy this was found to be right-sided. The left kidney gave no evidence of involvement. The right ureter was partially obstructed near the pelvis. The diminution of the function of the right kidney was very definite. Table IX shows the result of the examination of her urine.

The illness was so acute that premature delivery was seriously considered. Drainage, however, was established by inserting a ureteral catheter into the right ureter and leaving it *in situ* for some days. The pelvis of the right kidney was washed twice daily. This treatment obviated premature delivery and the patient went to term.

A complete examination in April, 1911, one year and six months after her first examination, showed that the affected kidney functionated almost, but not quite, as well as the left. An examination in November, 1913, gave similar results. There was at this time very little evidence of infection; only an occasional pus-cell was found, and there was no albumin. Pain, however, was most persistent, and after all other means to relieve this had failed, right-sided nephrectomy was performed. The kidney presented the appearance of a moderately advanced granular kidney. On microscopical examination it showed numerous areas of cortical fibrosis which accounted for the deformed appearance of the organ.

If we are correct in our deductions, the right kidney had been infected secondarily to the obstruction of the ureter and the damage done to this kidney by the acute and prolonged infection was sufficient to prevent the damaged organ from returning completely to the normal.

The second and third questions, i.e. what, clinical evidence, if any, warrants a safe prognosis, and what particular line of treatment is to be selected, are most difficult to answer. It is often possible, with careful clinical observations and repeated complete examinations of the urine, to form some idea of the progress of the infection, and to determine the amount, if any, of retention present in the pelvis and from these findings to establish a line of treatment. In most instances, we must be guided by the clinical course of the disease, including the type of infecting organisms.

Our present line of treatment is as follows:

Where some definite infection of the kidney exists, we are guided by the following:

1. The degree of diminution in function.
2. The length of time infection has been present.
3. The type of infecting organism.
4. The evidence of lesion as determined by X-ray, opaque, bougies, collargol, pyelography, etc.
5. The condition of the other kidney.
6. The general condition of the patient.

In the acute stage of the disease, as illustrated in certain cases referred to above, where there is no obvious interference with the drainage of the pelvis of the kidney, we do not operate at once. On the other hand, where definite and permanent obstruction to the flow of urine, where life seems threatened by toxæmia, or where a more chronic invalidism exists, and where a fair trial of other measures has failed, we explore the kidney and if necessary remove it. In some instances nephrectomy may not be necessary but in several instances where it was not done, after months of invalidism or weeks of acute illness, we have had to go back and remove a kidney to which palliative measures had been applied, as, for example, in Case 1, where at the first operation, we had hoped

by decapsulation, nephrotomy and drainage, to save the kidney.

Other means at our disposal are rest in bed, a plentiful supply of water by mouth, urinary antiseptics, of which urotropin and salol alone seem of benefit, and the establishing of drainage by posture, or what has in several cases given temporary relief, the inserting of a ureteral catheter by means of which there is established drainage for a period sufficiently long to give the kidney an opportunity to recover.

Vaccines have proved efficacious in two or three instances, but not in our hands during the acute stage. They have been used with the hope of preventing relapses. They should be autogenous and the dose controlled by the reaction. Rovsing has spoken very favorably of vaccines, and he is an authority of sufficient weight to lead us to believe that we have not got as much, perhaps, out of them as we might have. In many cases we have been disappointed even in the more chronic type.

PATHOLOGICAL LESIONS

The gross pathological findings in a kidney in acute infective nephritis vary with the distribution, size, and extent of the lesions and the duration of the disease. In the acute stage the kidney is increased in size. This may be so slight as to fall within the normal limits of variation, or it may be quite marked. The largest kidney in our series weighed 270 grams. This was a kidney in which the lesions were very acute and widely distributed.

The appearance of the capsule varies largely in proportion to the acuteness of the lesion, the severity of the toxin, and the extent of the involvement of the kidney tissue. The blood-vessels of the capsule are often distended, and in some cases there are small hæmorrhagic areas which bear a definite relation to the lesions of the kidney substance. In most instances, these hæmorrhagic areas are opposite the lesions in the kidney, though they do not always show this relation. In a kidney recently removed, where the disease was very acute and widely distributed, the intracapsular hæmorrhage was so extensive as to involve the greater part of the subcapsular tissue. The capsule may, however, show no gross evidence of lesions of the kidney cortex, even in the acute stage of the disease. Until the capsule in such a case has been removed, foci of infection in the kidney may not even be suspected. From the clinical viewpoint this is of importance. We have operated upon several cases where there was no gross external evidence of disease of the kidney tissue proper, but after removal of the capsule widespread acute lesions were found. It is important to the operator that this point be borne in mind. We failed to appreciate it in some of our earlier cases.

When the lesions in the kidney are large or when small and situated in the superficial portion of the cortex, the capsule is as a rule abnormally adherent to the underlying kidney substance. While these adhesions are slight in the early acute stage of the disease, they may in its latter stages increase in intensity and portions of the kidney substance be torn away when the capsule is removed.

The end-result of acute cortical lesions, in so far as the gross picture of the kidney with its capsule intact is concerned is well illustrated in Case 3 of our series. This patient had had acute infective nephritis one year before the kidney was removed. The locations of the previous lesions were indicated by depressed, thickened, firm, scar-like areas in the capsule, and throughout these areas the capsule was firmly adherent to scar tissue in the cortex of the kidney; the anatomical situation of healed focal areas of acute infection.

The most striking lesion in acute infective nephritis is to be seen in the kidney tissue proper. On the surface of the organ there are irregularly distributed focal areas of acute inflammatory reaction. These areas vary considerably in their location, size, number, and general gross appearance.

In our series, there has not been any definite uniformity as to their location, although in the greater number of cases, they are most numerous at the upper pole. All of them are elevated above the surrounding kidney tissue and in most instances are surrounded by a red zone. Some appear as small hæmorrhagic points, others as small pale yellowish areas, and still other larger ones, which are

made up of discrete and confluent foci of the same general character as the smaller ones. An area composed of discrete or confluent foci of infection, does not of necessity represent multiple areas of primary infection. On the other hand, they probably represent the local spread of a single infected focus.

When an incision is made through them they are found to extend varying distances into the cortex of the kidney and many of them are fan-shaped. While the distance to which they extend into the kidney substance is variable, they as a rule involve, for the most part, the cortical substance. The gross appearance of a section through them varies with their duration and size. Some of the earlier ones show but slight necrosis, most marked centrally, while the older ones show more extensive change, many of them having progressed to abscess formation. Between these cortical lesions, the tissues show the changes found in acute septic infection. While the lesions in our series have been most marked in the cortex they are not always limited to this area. The medulla may be involved as well and here the lesions are similar to, though as a rule smaller and less numerous than, those in the cortex.

The pelvis is not always free from evidence of involvement. In some of the cases there has been no demonstrable acute inflammatory reaction, though in other cases, such lesions have been present. The character of the pelvic lesions are those of acute inflammation.

The changes in the ureters likewise vary. Where there is no obstruction of it, there are no demonstrable lesions, but where obstruction is present, and the pelvis is involved, there is an acute ureteritis above the constriction.

There is in some of the cases an acute cystitis, but this is not always present.

When one takes into consideration the reaction on the part of tissues in general to inflammatory irritants, the variation in size of the kidneys in acute infective nephritis may easily be explained, and depends upon the factors that determine swelling associated with acute inflammation.

If the infection in the kidney is controlled and the patient recovers, the final gross picture of the organ will depend upon the balance between the various factors entering into tissue reaction to inflammatory irritants in general, and the time that has elapsed since the primary infection. These same principles will determine the terminal gross characters of the pelvis and ureters.

We can imagine a lesion so mild as only to injure and not destroy. Function might be restored after such a lesion. The injury may, however, be so extensive and severe as to lead to widespread tissue destruction with its accompanying changes. Between the two extremes, one finds all gradations.

The microscopical findings, in the series of kidneys examined, show a varying picture. In the earlier stages there is dilatation of the blood-vessels, diapedesis, exudation, and slight necrosis. From this type of lesion, there are various changes from a more extensive necrosis to the formation of small and large abscesses. The kidney tubules which are most intimately associated with the foci of infection contain the products of exudation. In the older cases scars, with the changes that characterize them, are present.

BACTERIOLOGY

A member of the colon group of bacilli has been recovered in the majority of the cases, either from the catheterized specimen of urine from the ureters, or from the infected areas in the kidney tissue. It is of interest to note that whatever organism has been recovered it has in all our cases, with the exception of one infective nephritis in typhoid fever, been in pure culture. Of 54 cases where samples of urine from individual kidneys were obtained by ureteral catheterization and where the lesion was evidently in the kidney, though in a few instances this was not definitely proved, 45 gave growths of a member of the colon group of bacilli, one staphylococcus aureus, two bacillus typhosus, 1 bacillus pyocaneus, and one the proteus of Hauser.

Of the series of 13 acute cases confirmed by operation and referred to above in some detail, 8 showed growth of bacillus coli, either from the urine or the lesions in the kidney, or from both; one staphylococcus

aureus. In the three remaining cases there is no note of the infecting organisms.

Lindemann found the following figures in 47 cases:

39 cases bacillus coli, 81 per cent.
2 cases staphylococcus aureus.
1 case proteus.
1 case bacillus coli and staphylococcus.
1 case bacillus coli and streptococcus.
3 cases sterile.

DISCUSSION

There has been a good deal of interest in the fan-shaped arrangement of the early lesion referred to above. This arrangement has been used in support of the opinion that these lesions are primarily due to an ascending infection, but we hope to show later that in most cases, this is not true. In an article in the *Berliner klinische Wochenshrift*, 1911, No. 44, Frank has shown that there is a direct lymphatic connection between the ascending colon and the capsule of the right kidney, and a probable similar connection between the left kidney and the descending colon.

There is, therefore, a possible easy route through which bacteria from the intestinal tract might reach the kidneys. This is made more probable as the lymphatics of the kidney capsule and those of the kidney tissue anastomose. Moreover, Trumpe has demonstrated that colon bacilli are frequent in the urine of children with catarrhal enteritis.

It is probable, however, that we must go further and regard these lesions of the kidney as secondary to a bacteriæmia.

In the cases of acute infective lesions of the kidney developing in individuals suffering from furunculosis, typhoid fever, tuberculosis, mastoiditis, and other kinds of septic foci, there is little doubt that the infecting organisms are blood borne. The fact of the absence of lesions in the pelvis of the kidney and urinary bladder in some of the cases, especially the earlier ones not complicated by partial obstruction to the outflow of urine, seems to be of some importance in its bearing upon the route through which organisms reach the kidney.

On the other hand, we would not deny that ascending infections of the kidney, may, and do, take place, but in the type of infection under consideration, we feel that the evidence is very strong for a descending rather than ascending infection, hæmatogenous or lymphatogenous rather than urogenous.

There are certain further arguments that tend to support this view:

1. Positive blood culture coincident with, or preceding, the kidney lesion. This was proved in only one of our cases.

2. The later development of lesion elsewhere in the body caused by the same organism as the one found in the genito-urinary tract; e.g., epididymitis which was present in one of our cases. We have also had one case which developed femoral phlebitis.

3. The analogy furnished by tuberculosis of the kidney which we think has finally been established as a blood or lymph-borne infection.

4. The fact that in certain cases lesions can be demonstrated in the kidney while as yet the lower urinary tract is unaffected.

5. It is not necessary that a bacteriæmia, in the clinical sense, precedes the lesion in the kidney. Infections of the kidney occur in furunculosis, and other types of local infection, without clinical evidence of bacteriæmia.

The relation between these infections in the kidney and the improper drainage of its pelvis is not a constant one. We feel that when obstruction is present, it is important for at least two reasons: first in its relation to the development of the condition, and second, its influence upon the course of the disease. The improper drainage of the pelvis must have some influence upon the functioning of the kidney, and may lead to lowered resistance and susceptibility to infection. The relation of obstruction to the clinical course of the disease seems to us to be of more importance than its relation to the primary infection. When once the kidney is infected, the possibility of its recovery without operation bears some relation to drainage. Infected lesions of the kidney, like those elsewhere, require proper drainage to facilitate rapid recovery.

SYNOPSIS OF CASES OPERATED ON FOR INFECTIVE NEPHRITIS

CASES 1, 2, 3, 4, and 6 reported above.

CASE 5. Mrs. M., age 33 years, June 9, 1905, right kidney, multiple abscesses, nephrectomy, recovery.

CASE 7. L., age 30 years, October 9, 1907; acute illness, right kidney, diagnosed October 9. Improved, relapsed, nephrectomy. December 17, 1907, after re-examination which showed no change, but smears showed large Gram negative bacilli in large quantities. Recovery.

CASE 8. Mrs. W., age 50 years, December 28, 1907, acute illness, left kidney, history of an albuminuric retinitis 20 years previously during gestation. Operation. Kidney studded with small abscesses beneath the capsule, nephrectomy, recovery. In other ways this kidney looked like a well advanced interstitial nephritis, but the urine showed no albumin or casts.

CASE 9. F., June 2, 1912. Subacute illness with acute exacerbation. Old history of blow on the kidney. Old history of transitory albuminuria, right kidney, nephrectomy and drainage, recovery.

CASE 10. Miss B., age 47 years, December 18, 1907, acute illness, right kidney, small abscesses, nephrectomy and drainage, recovery.

CASE 11. E. W., age 18 years, May 13, 1911, right kidney, nephrectomy and drainage, acute illness continued, nephrectomy, recovery, kidney studded with small abscesses.

CASE 12. S-12-193, March 19, 1912. Acute illness, right kidney, nephrectomy, recovery.

CASE 13. Mrs. J., age 40 years, May 4, 1911, acute illness, left kidney, multiple abscesses, nephrectomy, recovery.

CASE 14. E., age 20 years, February 19, 1912, acute illness, left kidney, nephrectomy, multiple abscesses, femoral phlebitis, recovery.

CONCLUSION

1. There is a type of acute infective nephritis, the gross picture of which is characterized by multiple, small or large areas of acute infection which may, and as a rule do, proceed to abscess formation.

2. These areas are for the most part situated in the cortex.

3. The infection is usually unilateral.

4. Clinically, it is manifested by all the signs and symptoms of an acute illness.

5. The lesions produced may resolve or may leave the kidney so damaged that complete recovery is impossible and may serve as foci upon which further infection may develop.

6. The commonest infecting organism is a member of the bacillus coli group, but other organisms as staphylococcus and bacillus typhosus may produce similar lesions.

7. The infection is in most of the cases probably lymphatogenous, or hæmatogenous, and in some of the cases of bacillus coli infection, some abnormal condition of the gastro-intestinal tract, seems to play a distinct part.

8. There are frequently no demonstrable lesions of the genito-urinary tract which might contribute toward the localization of infection in the kidneys.

9. Treatment may be palliative, but operation may be necessary.

10. If nephrectomy is required and is performed early in the disease the prognosis is good.

HÆMATOGENOUS INFECTION OF THE OVARY

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HÆMATOGENOUS infection of the ovary can occur, just as any organ or tissue of the body can become the nidus of growth for pathogenic bacteria carried in the circulating blood. The frequency and importance of such infection of the ovary have not received due attention or emphasis.

The work of Rosenow and Davis[1] should serve to kindle interest in this subject anew. They state "That some infections of the ovary may be of hæmatogenous origin from a distant focal source, and not by direct extension from the genital tract, is supported by many clinical observations, and the demonstrated fact that bacteria from foci of infection . . . tend to infect electively the corresponding organs in animals when injected intravenously."

They draw attention to the frequency of tonsillitis followed by symptoms of pelvic infection; also to the occurrence of pelvic infection following anginal attacks during the menstrual period. Their theory of hæmatogenous infection with the streptococcus viridans as the cause of chronic fibrocystic degeneration of the ovaries has not as yet been substantiated by other observers.

In summarizing they lay stress upon the finding of the streptococcus in the fibrocystic ovaries of a young woman with a complete atresia of the vagina. This is the only clinical case included in their paper as published in the *Journal of the American Medical Association* in which the hæmatogenous source of the infection would seem to be definitely proven.

It will not do loosely to classify cases as hæmatogenous in origin where there is a possibility of infection by direct extension from the genital tract. In order rigidly to exclude infection by extension the following conditions must prevail: (1) intact hymen; (2) no coitus; (3) no history or evidence of gonorrhœa or vulvovaginitis in infancy or childhood; (4) no vaginal discharge whatsoever; (5) no local or intrauterine medication or instrumentation; (6) no focus of suppurative inflammation within the peritoneal cavity.

The necessity of most of these conditions is quite obvious. The mere fact that the patient is a virgin by no means excludes the possibility of ovarian infection from below. Infection through the introduction of foreign bodies into the vagina (douches, masturbation) is an ever present possibility. A most careful examination must be made to exclude inflammation of the urethra, vulva, and cervix. In the presence of any vaginal discharge whatsoever one cannot be certain of the hæmatogenous nature of a deep pelvic infection, unless the vaginal secretion be proven free of pathogenic organisms by culture.

Any labor or abortion, even if many years have elapsed before the occurrence of symptoms of ovarian infection, may still have been the causative factor.

The ovary is by virtue of its physiology peculiarly susceptible to infection by extension from any intraperitoneal suppurative process. This holds good even if the primary focus be at a remote portion of the peritoneal cavity. It is well known that in carcinoma of the stomach the ovary is frequently the seat of secondary growths. I believe that it is now the generally accepted view that these occur by implantation and not by metastasis through the blood or lymph stream. The periodic bursting of corpora lutea with the formation of a raw area extending more or less deeply into the parenchyma of the ovary would seem to offer a fertile field for the sowing of any existing intraperitoneal infection.

When all these conditions have been excluded, there still remain the cases of undoubted hæmatogenous infection of the ovary. These usually occur in pre-existing cystic conditions expecially in the remains of the corpus luteum. Thus far the best known and most frequently

[1] The bacteriology and experimental production of ovaritis. J. Am. M. Ass., 1916, April 15.

reported form of such infection is with the bacillus typhosus. In a previous communication [1] I reported such a case. A girl of thirteen years of age, shortly after her convalescence from a typical, rather severe typhoid fever, was operated upon for a large dermoid cyst of the ovary. Cultures from the cyst contents taken immediately after its removal showed bacillus typhosus.

I wish to report now a case of hæmatogenous infection of the ovary with the streptococcus hæmolyticus.

Melanie R., Surgical Number 165350, aged 18, high school girl; admitted to the Second Gynecological Service, Mount Sinai Hospital, July 19, 1916. Family history – negative. Past history: two months before admission the patient had an attack of right sided abdominal pain which was treated with the ice bag. Menstruation began at 14, irregular in type occurring every 5 to 6 weeks, lasting five days; painless. Last menstruation two weeks before admission.

Present illness: for two months the patient has been troubled with constipation and abdominal cramps, which became much worse during the past three weeks. No loss of weight; no sweats. The patient herself noticed a large abdominal mass.

Examination: The patient is thin, somewhat anæmic, the temperature is normal. Throat negative. Abdomen lax, tympanitic. In the right lower quadrant there is a large firm mass dipping into the pelvis. Hymen intact; no redness of urethra, Bartholin ducts, or vulva; no vaginal discharge whatsoever. (Examination with a small endoscope postoperatively showed no discharge from the cervix, the vaginal and cervical mucosa being everywhere dry, pale smooth, and normal.) The vagina barely admits one finger. Uterus not enlarged, anteverted, somewhat fixed. To the right of the uterus is a firm, slightly elastic mass, fixed, not tender, the size of a grapefruit. The finger passed into the rectum meets a marked constriction about six centimeters from the anus, in front of which a very hard fixed mass is felt.

There is no reaction to old tuberculin. With these findings and a normal temperature, our pre-operative diagnosis was either a solid ovarian growth, in all probability malignant, or an unusually firm ovarian cyst.

Operation. Extramedian hypogastric incision; omentum found adherent to uterus and right adnexa. Omentum freed and large ovarian mass found on right side firmly adherent to the broad ligament, the posterior surface of the uterus, and the rectum; slight congestion of the distal half of the right tube in contact with the mass. The uterine half of the right tube as well as the left tube and ovary were normal.

Procedure. Dense adhesions freed and mass delivered into wound. During this manipulation a small rent was made in the abscess wall and some greenish pus escaped. The abscess was clamped off by its pedicle and removed. There was troublesome oozing from bed of abscess. Because of this a gauze drain was placed in the bed of abscess and brought out through the lower angle of the wound. A normal appendix resected. The wound was sutured in layers.

Specimen. Abscess size of grapefruit, the wall of which is about one-half centimeters in thickness, filled with thick greenish yellow pus. Pathologist's report: ovarian abscess, probably infected corpus luteum cyst. Cultures of pus from abscess: hæmolytic streptococcus.

Convalescence was febrile for four days, then normal. The wound healed *per primam* except in the drained angle. The patient was discharged eighteen days after operation with the wound entirely healed, the uterus movable and a slight infiltration on the right side. Re-examination three months later showed the patient in excellent health, the scar firm, and the pelvic contents normal.

The absence of inflammation of the fallopian tube is further corroborative evidence that the infection did not spread to the ovary by extension from below. We were unable to discover the original source of the infection.

It is highly desirable that similar cases should be studied and reported, so that this condition may be definitely established as a pathological entity. Such reports will serve to clear up the question of the frequency or rarity of this condition. In addition to its clinical interest and importance, the possibility of such infection of the ovary is not without sociological significance in the life of the patient.

[1] A study of the complications of ovarian tumors. Am. J. Obst., N. Y., lxxii, No. 2.

DEPARTMENT OF TECHNIQUE

THE TROCAR–HARPOON METHOD OF FOREIGN–BODY LOCALIZATION WITH A NEW HOLDER

By EDWARD S. BLAINE, M.D.
Captain, Medical Corps, United States Army

THE trocar-harpoon procedure of locating projectiles under the X-ray fluoroscopic screen was described by Sutton in 1915. Later Skinner described Sutton's technique and corrected errors in the earlier publication. Recently this method was described by Flint who used an improved harpoon. The earliest reference to the procedure is that of Perthes in 1902 under the title of *Fremdkoerperpunktion* and later described by him as *Fremdkoerperharpunierung*. Sutton's application differs but little from that employed by Perthes. It was while in the service of the British Expeditionary Forces during the early period of the present war that Sutton encountered tremendous difficulties in his work of removing projectiles from the wounded. He had nothing to work with but an inferior X-ray equipment, which consisted of a small coil, some inefficient tubes and a very inadequate dark room which made platemaking almost out of the question, so that he was denied the usual assistance that the modern X-ray laboratory affords the surgeon. Due to this condition of circumstances he sought recourse in the fluoroscopic means of projectile localization and removal, and his name is now often associated with this method.

The roentgenoscopic screen is arranged to be held horizontally over the table about 15 centimeters above the patient, the X-ray tube being underneath. The projectile to be localized is centered on the screen and the skin and underlying tissues are anæsthetized with novocaine or other similar agent. A cannula to which has been attached a small wing at the breech is used. With trocar inserted, the cannula wing is held by an artery forceps directly over the projectile in the central X-ray with narrowed diaphragm. The instrument is pushed through the skin into the deeper tissues and if structures liable to damage be encountered the sharp trocar may be replaced by the obturator (Fig. 2). Some operators prefer to incise the skin and dispense with the trocar. Great care must be observed that the instrument be pushed in a perfectly straight downward direction, this being controlled by the shadows on the screen. If the point of the trocar be visualized beyond the shadow of the breech, it is proof positive that the direction is wrong and that the point will not reach the projectile; therefore the instrument must be drawn back slightly and again advanced in the correct line. When the point has reached the projectile the operator as well as the patient will be aware of the fact, but to verify this, one may slightly displace the tube and the shadow of the point will be seen to appear and will lie in contact with the foreign body. Movement of the instrument will also move the projectile. The obturator is now removed and a wire harpoon inserted in its place. Then holding the harpoon firmly in position to keep it in contact with the projectile, the cannula is withdrawn leaving the harpoon *in situ*. The wire shaft of the harpoon may be cut off with the wirecutting pliers furnished with the set and may be bent at right angles to the skin and dressings applied. The surgeon now needs but to follow the shaft of the harpoon until he reaches the projectile.

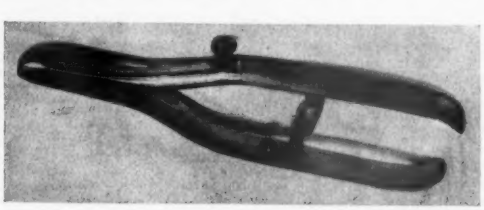


Fig. 1. Modified Wedel needle-holder for holding cannula.

Flint, in advocating this method, reports considerable difficulty in the course of operation on account of the dark color of the Sutton wire harpoon which often cannot be distinguished in the blood-stained area. He therefore has had harpoons made of white metal such as is used

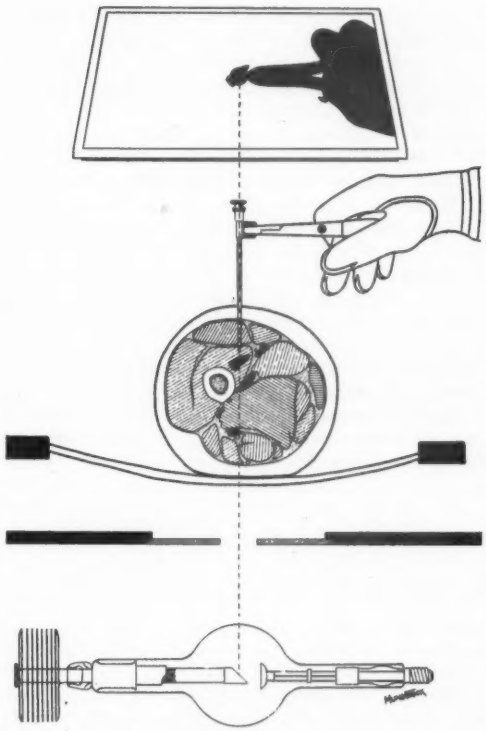


Fig. 2. Upper portion of diagram represents the X-ray shadows as seen on the screen. The diaphragm must not be opened enough to include the hand as shown. In the middle portion is the proper position of operator's hand, holder and cannula, the latter directly in line with the central ray. In this position only will the shadow appear as indicated.

in the manufacture of surgical instruments, the diameter of the shaft being the same as that of the obturator. (Fig. 3 *A*.) This special harpoon has a small piece of metal hinged at the point which opens out away from the shaft, thus sticking into the soft tissue and holding the harpoon in place. The color is such that it can be easily seen under any operative condition. These are used repeatedly while the wire harpoons are used but once.

The writer has experienced great difficulty in controlling the introduction of the cannula when using the artery forceps as directed by Sutton. This is because there is insufficient bite to the jaws when clamped on the wing of the cannula. If tissue of considerable resistance be encountered the instrument will slip and all control is lost. A successful means of overcoming

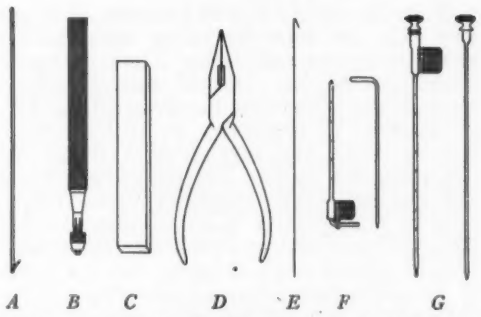


Fig. 3 *A*, Flint's special harpoon; *B*, chuck used in making wire harpoons; *C*, sharpening stone; *D*, wire-cutting pliers; *E*, completed harpoon; *F*, and *G*, large and small sized cannulæ.

this objection is found in the use of a modified Wedel needle-holder, the jaws of which have been ground down to fit the wing on the cannula. (Fig. 1.) The handle of this holder is long and well shaped to fit the hand and is long enough to permit the operator's hand to be beyond the direct X-ray during the entire procedure. It can also be handled with ease with heavy X-ray lead-rubber gloves should it be desired to use this protection, but the careful operator will never open the diaphragm enough to expose his hand. The holder is locked by simple pressure on the handle and is as easily unlocked by button release conveniently placed. When set in position for use the bite is such that it cannot slip in any degree, in fact the cannula itself will bend before the holder will be dislodged. It is found that this holder affords a very positive control of the instrument in its passage through the tissues to the projectile and its use will insure success when the ordinary artery forceps will often prevent a satisfactory result.

An even more direct application of this harpooning method has been obtained by using the Flint harpoon with the modified needle holder just described. The cannula and trocar are both dispensed with by making a small incision through the skin directly over the projectile and then passing the Flint harpoon in identical manner as previously detailed. In the hands of a skillful operator this materially shortens the proceeding but it must be noted that the harpoon must be accurately directed as it will be impossible to withdraw the instrument should it go in a wrong direction. The smaller shadow cast by the slender shaft of the harpoon as compared with that of the trocar lends itself to a much easier control of direction.

When the supply of wire harpoons gives out new ones are made by taking some No. 23 gauge piano wire and cutting it into 10 to 12 centimeter lengths. One of these is passed through the hollow handle of the chuck (Fig. 3) allowing ½ centimeter to protrude from the end and the wire is held firmly by tightening the clutch. The protruding wire is now rubbed on the sharpening stone (Fig. 3, *C*) until a very sharp point is obtained. Release the chuck and move the wire out a short distance farther and lock again. Set the width of the jaws of the wire-cutting pliers (Fig. 3, *D*) on the point of the wire and bend it sharply backward, doubling it upon itself. This completes the harpoon which is removed from the chuck for use. The hook must not be greater than will easily pass through the cannula. A large and a small size cannula (Fig. 3, *F* and *G*) are provided with the standard set.

Objections may be offered to this method of projectile localization on several counts. Great care must be exercised in all steps of the procedure that they be performed under strictest asepsis. The danger of damage to vital structures must always be considered and it should only be used by those whose experience and skill in surgery is such that the use of this method is warranted.

While the trocar-harpoon method is one of the official methods, adopted by the medical department of the United States Army, its use is not encouraged because of the reasons stated in the preceding paragraph. Nevertheless the simplicity, directness and absence of all mathematical calculation, scales, X-ray plates and other time-consuming maneuvers, appeals to many who are engaged in the work of foreign-body localization and removal when large numbers of cases are to be handled in a short time under trying conditions.

A SELF-RETAINING RETRACTOR FOR USE WITH ALBEE BONE OUTFIT

By Major JOHN B. LOWMAN, M.C., and Captain R. B. PRATT, M.C.
U. S. Base Hospital No. 38

OPERATIVE orthopedics today can fairly well be divided into two schools, pioneered, developed, and still led by the masters in these individual fields—Albee and Lane; the one, the school of the internal fixation of autogenous bone graft; the other, that of the use of metal plate. It is not purposed to discuss their relative values. Sufficient it is that with the great increase in operative orthopedics there will be a much greater increase in the use of the Albee than of the Lane method. The Albee method is inseparable from the utilization of the electric driven saw, drill, etc., which he devised. With the great usefulness of this apparatus there are coupled certain dangers growing less with the increasing experience of the operator but still present when in the hands of an expert. These dangers are obvious to any one using or witnessing the use of the Albee outfit. To many surgeons, upon whom the stress of war will throw orthopedic surgery, this will practically be a new appliance. To add to its safety, to render bone work on the extremities easier by removing assistants and increasing the freedom of the operator, the retractor herein

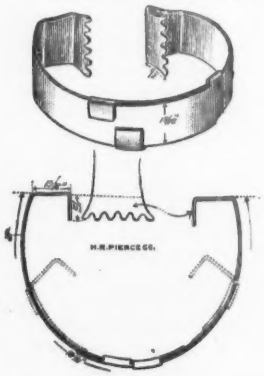


Fig. 1.

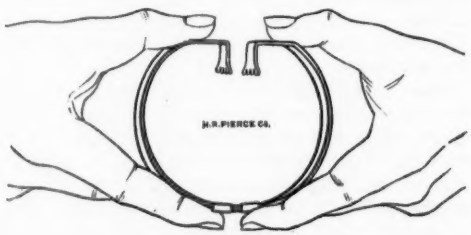


Fig. 2.

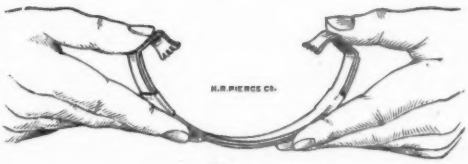


Fig. 3.

described was devised and has been found so far to fulfill the need in a satisfactory manner.

The retractor is made of two arcs of spring steel fixed together by lateral lips in the manner shown in the mechanical drawing Figure 1.

The toothed portions are broad to give greater and more even retraction. The teeth are rounded and the angle of adjustment between the retracting edge and the upper short horizontal surface is such that at no time is there any indentation of tissue except over an area sufficiently broad to prevent trauma. The lateral lips furnish a simple friction lock whose function is increased by any force exerted upon the two parts of the retractor except exactly in the direction of its arc by means of which the retractor is opened and closed. The accompanying drawings make this clear.

To apply the retractor, the limb, having been sterilized in its entire circumference, is lifted, the retractor sprung open sufficiently to slip on from below to nearly encircle the limb, the toothed edges being brought to either side of the proposed line of incision. Two retractors should be used in the average case. They can be pushed upward and downward out of the way until the incision and the exposing dissections are made. The cut surfaces are covered by towels layed lengthwise and their surplus width is tucked in about the limb and inside the grasp of the retractors. The toothed edges of the retractor are made to engage in the depth of the wound on either side of the bone and each half is pushed backward into the reciprocating embrace of the other until the desired exposure is accomplished. Any unevenness of the protecting toweling is corrected. The operation is performed and when finished the retractor is removed by pulling upward on the horizontal place of one-half and pushing backward in a circular direction upon the locking end of the other half on the same side of the limb. The retractors in position are shown in Figure 4,

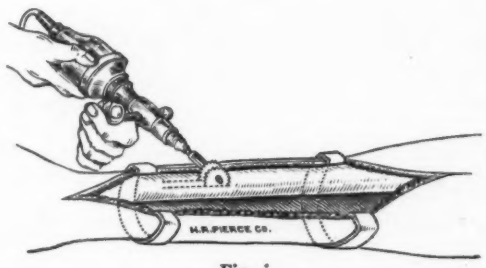


Fig. 4.

toweling having been omitted for clarity of diagram.

ADVANTAGES

1. Simplicity. There are no parts to be lost. It is easy to clean and sterilize and manipulate.
2. Durability.
3. Moderate cost of production.
4. It not only gives *retraction* of tissues but also *depression* of them with an uncomplicated automatic lock in any degree of retraction. Pressure upon its lower surface by the weight of the limb forcing it against the operating table only serves to increase retraction and locking.
5. It does away with retraction by assistants and with this the danger of extra hands in the operative field, uncertainty of position, sudden moves, and leaves the operator unhindered in the use of the electric saw and drill.
6. It leaves the bone in a higher plane than the surrounding tissues and so obviates the danger of the saw, drill, or spinning shaft engaging with the soft tissues or toweling.
7. In conjunction with an orthopedic table, assistants can be dispensed with during that stage of the operation in which the saw or drill is in use.
8. It is a useful addition in a teaching clinic in that it renders the field of operation more visible to spectators.

In old cases density of tissues may prevent proper retraction but this no more militates against this than any other form of retractor.

It will be found advisable to have a larger and smaller size for thigh, forearm and extremities of children.

The routine adoption of this retractor with the Albee outfit is recommended.

A NEW TRANSFUSION APPARATUS

By J. SHERMAN WIGHT, M.D., Brooklyn
Long Island College Hospital Research Department

A BLOOD transfusion set should be simple and foolproof. Clotting obstructs the syringe and connecting tubes. This is overcome by changing syringes and tubes. There are a number of different instruments in use but most of them are awkward and complicated.

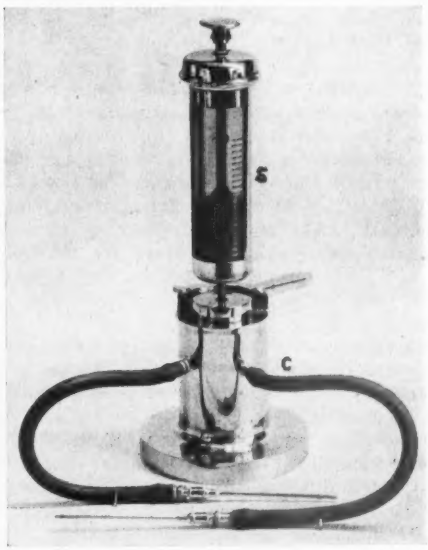


Fig. 1.

The instrument which I offer is shown in the accompanying cuts. The cannulæ are provided with a small off-set near the end so that they cannot slip out of vein when tied. These are connected to the instrument with rubber tubes, No. 17, French. There is a heavy metal cylinder *C* and a metal piston *P*, fitted with a collar and handle. The cylinder has two tapered holes in its wall to receive the two connecting tubes that go to the cannulæ and two pieces of metal on top to act as guides for the handle of the piston. The piston has a tapered hole at the top center to receive the syringe. This hole meets a hole in its side at right angles, which is on the same level with the holes in the cylinder when the piston is in place. The hole in the piston becomes continuous with the holes in the cylinder wall by turning the handle to the extreme limits of the guides. This instrument is heavy enough to rest on a table between the donor and recipient. Three to four hundred cubic centimeters of blood can be introduced without change of syringe. The instrument can be easily cleaned.

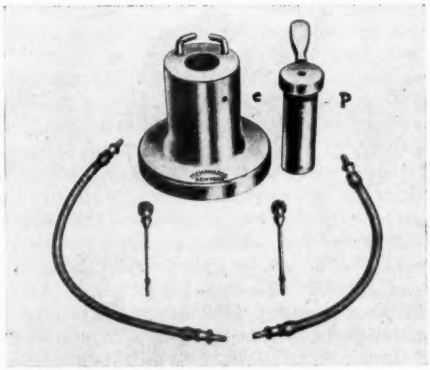


Fig. 2.

PARALYSIS OF THE UPPER EXTREMITY DUE TO COMPRESSION OF THE BRACHIAL PLEXUS BY SCAR TISSUE

Operation; Recovery[1]

By FRED C. WATSON, M.D., Quiriguá, Guatemala
Surgeon, United Fruit Company Hospital

THE present European War with its colossal total of wounds of almost every imaginable variety has caused us to realize the importance of wounds of the peripheral nerves and has stimulated an added interest in this important branch of surgery.

In this connection the following statistics of Moynihan (1) as to the relative frequency of injuries of this type are of interest.

Nerve.	Per Cent.
Musculospiral	25
Ulnar	24
Median	14
Sciatic	12
External popliteal	12
Internal popliteal	1
Upper portion of the brachial plexus	4
Lower portion of the brachial plexus (cords)	7
Anterior crural	1

It will be noted that injuries of the brachial plexus form 11 per cent of the total number of wounds involving the peripheral nerves. Injury to the brachial plexus in adults is usually the result of indirect violence and in such cases is associated with skeletal injury, such as dislocation of the shoulder, fracture of the head of the humerus, or fracture of the clavicle. However skeletal injury is not necessarily associated as was shown by Frazier and Skillern (2) in 1911. They were able to collect reports of 21 such cases, all of which were verified by operation.

Law (3), in 1916, reported two very interesting cases of this kind and cited two other cases from the literature, one by Hartwell and one by Murphy. In these cases, complete or incomplete avulsion of one or more of the component parts of the plexus results from the violent stretching to which the plexus is subjected. A similar condition is not at all uncommon at birth and likewise is due to indirect violence.

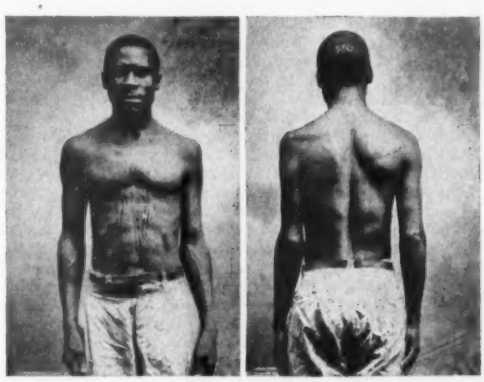
The plexus may be injured by direct violence, such as occurs when the clavicle is driven downward against the first rib. These cases are comparatively rare. In the case to be reported, it would seem that both direct and indirect violence were responsible.

Uriah Harris, case history No. 5417, male, black, Jamaican, age 32 years, occupation banana cutter, was admitted to the hospital March 25, 1915. On the evening of March 19, 1915, after drinking rather heavily, the patient fell backward from the porch railing on which he was sitting, to the ground, a distance of ten or twelve feet, striking on the upper and back part of the left shoulder. In falling the left arm and forearm were carried behind the trunk. Paralysis, motor and sensory, of the entire extremity was noticed the next morning when he had recovered from the effects of his drinking. Severe cramp-like pains, numbness, and tingling were occasionally felt in the left shoulder radiating down the arm and forearm.

On examination a few superficial abrasions and contusions about the upper and posterior surfaces of the left shoulder were noted. There was no evidence of fracture or dislocation. There was complete anæsthesia corresponding to the cutaneous distribution of the circumflex, musculospiral, and ulnar nerves. Sensation corresponding to the cutaneous distribution of the internal cutaneous nerve was impaired. Above the acromion process and the spine of the scapula, sensation was normal. There was complete paralysis of the following muscles: the deltoid, triceps, supinators, and the extensors of the forearm and wrist. The biceps was active only when the arm and forearm were flexed at a right angle. The flexors of the forearm were normal. The pectoralis major and minor, the latissimus dorsi and teres major were active. The muscles above the acromion process and the spine of the scapula were also active.

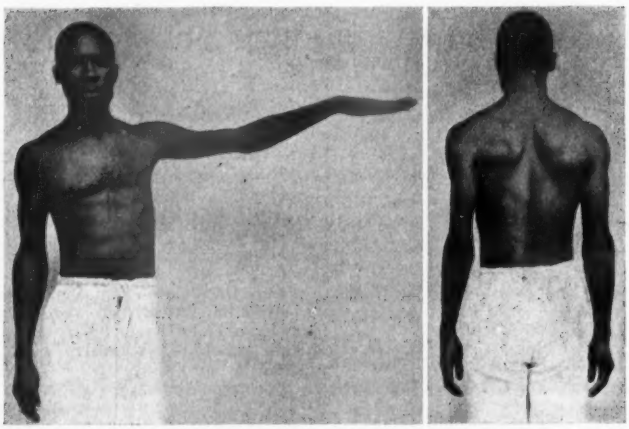
Upon analyzing our findings then we concluded that the patient had an injury, probably an avulsion of the inner and posterior cords of the brachial plexus, below the origin of the long, middle, and short subscapular nerves and the suprascapular nerve.

Operation was advised but was refused. The patient was kept under observation for nearly three months and as trophic changes became more and more marked his consent was obtained. The trophic changes are shown in Figures 1 and 2.



Figs. 1 and 2. Anterior and posterior views of patient with compression of left brachial plexus before operation.

[1] From the Medical Department of the United Fruit Company, Bocas del Toro, Republic of Panama.



Figs. 3 and 4. Same patient five months after operation.

Figs. 5 and 6. Final result 2 years after operation.

It will be noted that there is an absence of the normal deltoid bulge and that there is an increased prominence of the spine of the scapula due to the complete paralysis of the deltoid muscle. The extremity is about an inch and a half longer than its fellow of the opposite side due to the relaxation of the structures about the shoulder-joint. There is atrophy of the supra-and infraspinous muscles but this is probably from disuse as their innervation seems normal. The triceps is markedly atrophic. There is beginning wrist drop. The extremity is rotated somewhat outward and backward and hangs limply against the side of the body. The general appearance is not unlike that of a dislocated shoulder.

Operation June 14, 1915, under ether anæsthesia. An incision was begun about two inches above the clavicle extending parallel and about one-half inch to the inner side of the sulcus between the deltoid and pectoralis major muscles to the lower edge of the pectoralis major. The clavicle was sawed in two; the pectoralis major and minor were divided close to the humerus; the subclavian muscle was now divided and the costocoracoid membrane opened up exposing the plexus. The three cords of the plexus were found to be compressed between the clavicle and the first rib by scar tissue, which upon dissection was shown to involve chiefly the inner and posterior cords. As the scar tissue was carefully dissected off, the plexus was found to be intact.

As the problem was then to prevent the reformation of scar tissue, a fascia transplant was removed from the patient's thigh and securely sutured about the inner and posterior cords using very fine catgut for the purpose. The divided muscles were now reunited with chromic catgut No. 2 and the clavicle drilled and held in place with kangaroo tendon. The skin was closed with interrupted sutures of silk. A Velpeau dressing was applied and the wound left undisturbed for fourteen days, at the end of which time it was found clean when the skin sutures were removed. The Velpeau was reapplied for four weeks, the arm and forearm then being placed in a sling. Mild passive motion was now started. The patient was discharged from the hospital August 5, 1915. Rapid improvement followed, as is very strikingly shown in Figures 3 and 4 taken November 25, 1915, a little over five months after the operation.

The normal deltoid bulge has returned and the arm can be held at a right angle to the body; the relaxation of the structures about the shoulder-joint has disappeared and there is no apparent lengthening of the extremity. The triceps is likewise regaining its normal contour. Sensation is nearly normal.

The final result is shown in Figures 5 and 6, taken June 20, 1917, a little more than two years after operation. While there is still a little weakness of this side in comparison with the sound side the patient is able to perform his duties and is well satisfied with the result.

In Figure 5 a keloid growth is seen at the site of the operation wound. These growths frequently follow operations in practically all parts of the body in the negro race and aside from the unsightly deformity caused by their presence are not considered of much importance. Efforts directed toward the removal of keloid growths are usually rewarded by an increase in the size of the growth, consequently they are usually best left alone.

In conclusion, I wish to thank Dr. W. E. Deeks, General Superintendent, Medical Department, United Fruit Company, for permission to publish this paper.

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3. Law, A. A. J. Am. M. Ass., 1916, Sept. 16, 865.

CORRESPONDENCE

THE BALDWIN OPERATION FOR ARTIFICIAL VAGINA

To the Editor: In the August issue of your Journal, Dr. A. W. Abbott, of Minneapolis, suggests a modification of the operation which I devised a number of years ago for the making of an artificial vagina, his modification consisting in utilizing a single piece of bowel instead of the double piece which I originally suggested. His modification is apparently a simplification of the operation, but I had carefully considered it before publishing my original communication and had decided that the single bowel would almost certainly be too small, particularly after time had elapsed for the contraction of surrounding connective tissue. My subsequent experience has fully confirmed that view. Nevertheless, and in verification of this statement, I may say that under date of August 21, I received a letter from Dr. J. G. Blower, of Akron, in which he refers to this article by Dr. Abbott, and states that in case of a patient of his upon whom I had made this operation three years ago, he had found it necessary (as I had suggested to him would probably be the case when his patient returned home), to remove by clamp the upper extremity of the septum which part had failed to disappear after my use of the clamp. The lower portion of the vagina was of normal size, but it was too small above until he destroyed this remaining bit of septum.

I may state that since my original publication of this method, I have learned of the performance of a large number of these operations, but have heard of only one fatality. That occurred at the hands of a German surgeon and was due to peritonitis. In one case, in New York, in a young girl of 16, the uterus was present, and the technique which I devised for such a case was employed with a successful result. I am hoping to live long enough to hear of that young woman becoming a mother, though doubtless it will have to be by cæsarean section.

Columbus, Ohio. J. F. Baldwin.

To the Editor: In regard to Dr. Baldwin's suggestion, I would say that the vagina in the case I reported was one and one-fourth inches in diameter at the end of three months. Contracture does not occur in the bowel but in the connective tissue at the vaginal orifice and where it perforates the pertoneum It would seem that these contractures (easily overcome by suitable dilators) would be as likely to occur irrespective of the size of the gut or whether a full loop or one limb were used. A satisfactory decision can only be reached after a large number of cases operated by this method. Dr. Baldwin's experience in this abnormality has been extensive and his opinion should certainly command the greatest respect.

Minneapolis, Minn. A. W. Abbott.

TRANSACTIONS OF SOCIETIES

CHICAGO SURGICAL SOCIETY

REGULAR MEETING, MAY 3, 1918, CARL BECK, PRESIDENT, IN THE CHAIR

FRACTURE OF THE UPPER THIRD OF THE FEMUR WITH A DISLOCATION OF THE HIP

DR. MALCOLM L. HARRIS: The case I wish to report is that of a frail looking boy, 12 years of age. While playing on a snow bank last January he fell and sustained what seemed, at first, to be a rather trivial injury. He was brought to the Alexian Brothers Hospital and it was found that he had a fracture of the shaft of the upper part of the thigh. While we could extend the limb the proper distance, the coaptation splints did not approximate the ends, as was shown by roentgenogram, so the case was operated on and a bone plate inserted with bone screws. The boy was put in a body and leg cast. When we examined him the next day, we were surprised to find that while the leg was perfectly straight and seemingly normal, it was shorter than the other. I immediately investigated and found that the trochanter on that side was too high. I immediately had the hip X-rayed, and found the hip was completely dislocated upward and backward; the femur was in perfect alignment at the fracture. We then anæsthetized the boy and tried to push the head of the bone back in place. This was impossible, so I concluded to operate on the hip and reduce it, which I did, after the boy had rested a few days from the first operation as he was rather delicate. Through an anterolateral incision, posterior to the tensor vaginæ femoris, a dislocation of the hip backward and upward was found. The ligaments were all torn, but with the short end and inability to make any traction by pulling on the leg, or manipulation we could make no impression on the upper end. Even with a large Lane bone forceps I was not able to manipulate the upper end to get the head in place; so I made an extensive dissection, and used the hip skid. Only after I got the skid in back of it and over the edge of the acetabulum was I able to skid the head back into place. I considered this a serious enough operation for the boy, so I sewed up the wound and waited. Naturally, as a result of the manipulation and getting the head back in place, the fracture plate came off. The manipulation pulled the screws out of the upper fragment. We were now still in a bad predicament; we had the head reduced, but our fracture was out. I put on extension to see what position the fragments would assume with the head back in place but found that extension would pull the hip down out of place. I therefore concluded to do another operation on the fracture. After waiting a few days, I cut down on the fracture again and replated it. While trying to get the ends of the bones together, a large piece split off the upper fragment, so that while at the first operation I had straight ends, this time they would slide by because the piece had broken off. After considerable difficulty I got the plate on, then I wired that fragment to the plate as that was the only way I could hold the whole thing in place.

I have just taken the last cast off. The boy has a movable hip, and we have a good union of the bone. We met, as you see, many difficulties in this case. It is the only case that I have ever seen where we had a fracture of the shaft of the femur in the upper third, with a dislocation of the upper fragment, in a child. I have seen several cases of fractures in adults, with dislocations, and fractures through the trochanter and upper part of the neck, but this is the only case I have ever seen of a fracture of the shaft of the bone with a complete dislocation of the upper fragment in a boy. I do not know of any way of handling these cases except by the two operations. It is impossible to get the head back without the skid, which means an open operation, and then it is necessary to operate on the bone.

If any member has had a case of this kind, I should like to hear from him.

DR. FREDERICK G. DYAS: Would it not have been possible to reduce the head of the femur in the first place?

DR. HARRIS: No. We tried it, and Dr. Hessert helped me, but we could make no traction on it and we could not push it back in place. We had to give it up and do an open operation. There was nothing to take hold of to make any manipulation.

DR. JOHN R. HARGER read a paper entitled "Sarcoma of the Liver in a Child of Seventeen Months."

TREATMENT OF FRACTURES BY MEANS OF A NEW RAILROAD SPLINT

DR. WILLIAM HESSERT presented a new railroad splint which will be described in a later issue.

COMMONER LESIONS PRODUCING BACKACHE

DR. WILLIAM E. SHACKLETON described the commoner lesions producing backache. (See p. 602.)

DISCUSSION

DR. JOHN A. WOLFER: I have been very much interested in Dr. Shackleton's work and have watched it during the last six or seven years.

There are two points he brings out that ought to be considered again. One is the fact that the fifth lumbar vertebra is frequently overlooked in X-ray work. You can have trouble with it, and as one goes over the vertebral column and comes down to the fifth lumbar vertebra he skips it. This was forcibly brought to my attention in the last few days in a case of Pott's disease, with caries of the fifth lumbar vertebra, with a large abscess, although a competent roentgenologist said there was nothing definite to be seen. There was a large retroperitoneal abscess, and when we opened the abscess there was found erosion of the vertebra.

A second point is that backache is often a forerunner for so-called sciatica. I have observed this in a number of cases of so-called idiopathic sciatica. It recalls to my attention two cases, one of a woman who came from Idaho. After she had been told that there was no relief for her sciatica, she had taken salicylates and every other concoction until she could not retain simple water. The attack of sciatica was ushered in by frequent backaches which were of the kind Dr. Shackleton spoke of, located in the lower part of the back about the fifth lumbar vertebra. She attributed her trouble to the fact that she had quite a large, husky child and in swinging the child around it brought on backaches and developed sciatica. X-ray examinations, with stereoscopic pictures, showed the fifth transverse processes normal; they did not impinge upon the sacrum or ilium. The sacro-iliac joint was wider than it is normally. We could see an anteroposterior displacement. We made out definitely that the sacral nerves of the sciatic were involved. She was given palliative treatment only, placed in bed with a pad on the sacrum, and traction made on the leg until the leg straightened and relaxed, and suddenly she had relief of pain. She was not given any sedatives, although she was given morphine before as she was unable to stand or sit. She assumed a recumbent position, and her pelvis was strapped with adhesive. She was sent to Pinehurst, and returned in six months after having worn one of Goldthwaite's corsets. She could dance and do anything she saw fit. She has not had a recurrence of the backache or sciatica.

Another case very similar to the one I have related did not complain very much of backache until one morning he went into the bathroom and in stooping over developed a sudden pain in the right side which radiated down the buttocks, and he fell upon the floor. He was a man 6 feet, 4 inches high. They had so much trouble in making him turn, and he complained so much of pain, that it was necessary to anæsthetize him to take him out of the bathroom. In this man's case the same thing was demonstrated. The fifth transverse processes were normal, but he had unmistakable slipping of the sacro-iliac joint. He was put to bed under similar treatment and the pain disappeared. He was a lawyer from Idaho and did not follow subsequent instructions as well as he should have done. But with complete rest, with a sacral pad he has not had a return of the sciatica or the backache.

It behooves all of us, as Dr. Shackleton has said, to see that these cases of backache are properly treated and not given backache medicine. We do not appreciate what backache is until we have had it. There are things overlooked in backache which come to light if we all watch our cases.

DR. R. W. HOLBROOK, Kansas City, Missouri: I am particularly interested in this paper because of the trouble we have had with some of our troops for the last several months. The bane of our existence has been a hæmolyzing streptococcus that we are having to deal with. Within the past six weeks we have had 15 men sent to the base hospital complaining of backache, a little dyspnœa, a slight weakness of the legs, as they express it, and a low grade temperature. Cultures were made from the throats of these men which disclosed a hæmolyzing streptococcus. After three or four weeks in bed they developed a myocarditis, and by instituting treatment similar to that described by the essayist, the backache and heart trouble have disappeared.

DR. WILLIAM M. HARSHA: I would like to ask Dr. Shackleton to clear up a little, for me, at any rate, the situation with reference to the articulation. I noticed several times he said the transverse process of the fifth was ankylosed in its attachment to the ilium. Again, he referred to it as articulating with the ilium. As I remember hearing Dr. Goldthwaite, in Boston, speak on this subject, he regarded as physiological the attachment of the fifth transverse process to the ilium in certain types he described of stout, heavily built people. People the opposite are the slender type of individuals who develop the possibilities of the gymnast and circus performer. I would like to know whether he regards all these cases with attachment of the transverse process to the ilium as pathological.

DR. ALBERT GOLDSPOHN: About two years ago a nurse in training, a stoutly built and healthy looking individual, began to complain of backache which radiated along the iliolumbar nerve on the right side chiefly. The trouble was sufficient to disable her and to necessitate rest in bed. I referred her to an X-ray man who does good work, and he was very positive in making out that there was an excessive length or an interfering deformity of the transverse processes of the fifth lumbar vertebra, and was equally positive in suggesting surgery only to afford relief. I then looked up the past experience up to that time of surgery for this anomaly, and found that in quite a number of cases operations had been followed by interference with nerves which resulted in lameness of the leg, sometimes interference with motility or sensation, and at other times both. In a number of instances these patients were confined to bed for a number of months before they

regained anything like their normal condition. I was rather surprised at these findings, and thought I would try what local treatment along these nerves could do, and began the hypodermic administration of iodin, beginning with one-quarter of a grain and carefully feeling my way upward until I gave fully one-half grain in an aqueous solution, twice a week, and was encouraged in this by the diminution of the local pain which eventually disappeared and has not returned. That individual is under my observation now and is thoroughly well.

In this connection I might mention something which will avoid perplexity with some surgeons. It is not exactly in this line, but more in a gynecological field. It has been my lot to treat two women who had the coccyx removed by good surgeons, one of them my chief, Professor Fenger, because the coxalgia continued and was not benefited by the removal of the coccyx. In this matter I was helped by a German gynecologist, that this backache in women is frequently not due to any anomaly in the bony structures, but due chiefly to a varicose condition of veins on the inner side of the sacrum which have some capacity to make pressure upon the sacral nerves. The trouble was removed, as was done by the man who made the first explanation of the pathology, by hydrotherapy in connection with internal massage.

Other similar backaches that have been through the hands of a number of men I have seen subside after curing a pronounced retroversion of the uterus, not simply bringing the uterus into a normal position but by overcorrection of the normal position by suspension of the uterus up against the abdominal wall, by the right use of the round ligaments.

Dr. Shackleton (closing): Anything which will impress upon the members of the society the fact that pressure upon the sacrolumbar cord will cause the symptoms I have mentioned is worth while.

In conversation with Dr. Patrick not long ago, he made the statement that he believed there was no such a thing as essential sciatica; that it was always due to some pathologic condition. It would be impossible in a short time to call attention to all of the things that would cause this change, so that I have dwelt in my paper more particularly on the conditions at the lower end of the spine, involving the sacrum and ilium and the lumbar vertebra.

Last fall one of our nurses came in with a severe backache, and a roentgenogram showed both transverse processes impinging upon the ilium in such a manner that we could rotate the last lumbar vertebra on the sacrum itself. She had entered the Columbia University for the purpose of teaching school children calisthenics, and she complained bitterly that she had overexerted. She came to me three days before she went back to Columbia, and I wanted the roentgenograms to show the doctor in New York.

In answer to Dr. Harsha's question, I believe both conditions occurred; in fact, I have seen them occur. You may remember the fourth and last slide I showed where there was double articulation of the enlarged transverse process on both sides. On one side the transverse process united with the ilium as a true joint surface. On the other side, the bones were grown together as if the periosteum had been scraped and a definite bony union occurred.

In regard to trouble following operation, in 1916 I reviewed all the articles I could find of conditions involving the transverse process, and at that time in all of the literature there have been reported only 20 cases of this condition, 14 of which had been operated on. One man reported 3 cases, and in 2 of his cases reoperation was required because not enough of the process had been removed at the first operation. Both cases were reoperated upon with relief following the second operation. I know personally two other cases which were operated upon, both failures, simply because the transverse process was not removed to relieve the pressure on the sacrolumbar cord. The danger of the operation seems to be injury to the sciatic nerve entirely. In the first case I operated on, before I succeeded in stripping off the loose pieces of bone, I had very decided response from pressure on the sciatic nerve. There was decided twitching of the leg, and to obviate the pressure on the nerve I slipped a curved periosteotome under the transverse process and had the assistant hold it up tightly while I chiseled off the transverse process with hammer and chisel. I can assure you it is not an easy operation. You are working down in a depth of three or three and a half or four inches and in a space about an inch and a half wide. You think you may be able to slip a Gigli saw around or take it off with bone biting forceps, but I have never been able to do so. In all cases the transverse processes had to be removed by hammer and chisel. The only thing to guard against in the operation is injury to the sciatic nerve, which undoubtedly occurred in the case the doctor spoke of and which caused the after-symptoms. In the fourth from the last case that occurred, for a period of ten days following the operation the patient had considerable pain and discomfort, and it was quite a little time before the patient was able to get around again. However, the symptoms subsequently cleared up.

Dr. Carl Beck discussed surgical reconstruction work during and after war.